UNITED STATES DEPARTMENT OF AGRICULTURE

EXTENSION SERVICE HANDBOOK

UNITED STATES
DEPARTMENT OF AGRICULTURE

Extension Service . . . C. W. Warburton, *Director*
Office of Cooperative Extension Work C. B. Smith, *Chief*

EXTENSION SERVICE HANDBOOK ON AGRICULTURE AND HOME ECONOMICS

Compiled and edited by

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U. S. Department of Agriculture

There is a great need that both rural and urban people should get more of a complete understanding of the educational, social, and economic significance of extension work in agriculture and home economics
—*A. C. TRUE*

OCTOBER, 1926

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON
1927

FOREWORD

At the thirty-seventh annual convention of the Association of Land-Grant Colleges held at Chicago, Ill., November 13 to 15, 1923, the following recommendation was presented by the committee on extension, organization, and policy and adopted by the general body assembled:

"To meet the demand of agricultural and home-economics field workers for readily available information, a uniform, loose-leaf handbook of agricultural facts is recommended, the same to be prepared through the cooperation of the Extension Service of the United States Department of Agriculture and the State agricultural colleges. In order that uniformity may be secured and that the cost be reasonable, the following suggestions are offered as a result of information received from agricultural extension workers:

"(1) That the standard size page, 3¾ by 6¾ inches, be adopted as a desirable uniform size. These can be secured to fit either ring or tape binder.

"(2) That the side-opening handbook seems the most adaptable for this purpose.

"(3) That all printed matter be in 6-point type.

"(4) That the United States Department of Agriculture be requested to adopt a system of preparing and issuing general extension material to the States, free of charge, upon the standard form page and type."

Based on the above request a department extension handbook committee was appointed as follows: W. A. Lloyd, chairman, Office of Cooperative Extension Work; H. M. Dixon and J. Clyde Marquis, Bureau of Agricultural Economics; W. B. Bell, Biological Survey; W. W. Skinner, Bureau of Chemistry; J. A. Hyslop, Bureau of Entomology; Miss Miriam Birdseye, Bureau of Home Economics; W. H. Beal, Office of Experiment Stations; O. S. Fisher, Bureau of Soils and Bureau of Plant Industry; F. C. Meier, Bureau of Plant Industry; J. B. Kincer, Weather Bureau; C. D. Lowe, Bureau of Animal Industry; S. H. McCrory, Bureau of Public Roads; G. H. Collingwood, Forest Service; and H. W. Gilbertson, Extension Service.

The general committee recommended that an editorial committee be appointed to work in conjunction with the chairman of the department extension handbook committee. C. W. Warburton, Director of Extension Work, appointed the following workers: G. H. Collingwood,

Forest Service; Miss Miriam Birdseye, Bureau of Home Economics; and W. H. Beal, Office of Experiment Stations. Acknowledgment is made to Carter N. Bealer, of this office, for his cooperation and able assistance in the preparation of the manuscript for the printer.

The primary purpose of the Federal handbook is to place in the hands of extension workers the practical results of the research of the United States Department of Agriculture that are ready for extension, and to continue this service throughout the future. To do this loose leaves will be prepared and released as soon as material is available and ready for distribution. An effort will be made to make each loose leaf a unit within itself and to treat each subject as fully as practicable in such limited space. The material has been classified on a subject-matter basis. With the additions to be made from time to time over a period of years each subject will make a handbook in itself.

The fine cooperation shown by the general committee, the editorial committee, and the committees of the various bureaus and offices has made this handbook possible.

C. B. Smith

Chief, Office of Cooperative Extension Work.

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GENERAL

GOVERNMENT OF THE UNITED STATES

Legislative Branch

Congress

Senate:
    96 Senators.
House of Representatives:
    433 Representatives.
    2 Delegates.
    3 Commissioners.

Executive Branch

The President

Judicial Branch

Supreme Court.
Circuit court of appeals.
United States district courts.
Various special courts.
Court of Claims.
Court of Customs Appeals.
District of Columbia courts.
Territorial courts.

I. Department of State

Division of Far Eastern Affairs.
Division of Latin-American Affairs.
Division of Western European Affairs.
Division of Near Eastern Affairs.
Division of Mexican Affairs.
Division of Eastern European Affairs.
Division of Passport Control.
Division of Publications.
Division of Political and Economic Information.
Division of Current Information.
Division of Foreign Service Administration.
Bureau of Indexes and Archives.
Office of Coordination and Review.
Visa Office.

II. Department of the Treasury

Commissioner of the Public Debt.
    Division of Loans and Currency.
    Register of the Treasury.
    Division of Public Debt Accounts and Audit.
    Savings system.
Commissioner of Accounts and Deposits.
    Division of Bookkeeping and Warrants.
    Division of Deposits.
Treasurer of the United States.
Comptroller of the Currency.
Bureau of the Budget.
Director of the Mint.
Federal Farm Loan Bureau.
Secret Service Division.
Government Actuary.
Foreign Loans, Railroad Advances, etc.
Bureau of Engraving and Printing.
Bureau of Internal Revenue.
Bureau of the Public Health Service.
Supervising Architect's Office.
The Coast Guard.
Bureau of Supply.
Customs Division.

III. Department of War

General Staff Corps.
Office of Chief of Cavalry.
Office of Chief of Field Artillery.
Office of Chief of Coast Artillery.
Office of Chief of Infantry.
Office of Chief of Chaplains.
Office of Adjutant General.
Office of Inspector General.
Office of Judge Advocate General.
Office of Quartermaster General.
Office of Chief of Finance.
Office of Surgeon General.
Office of Chief of Engineers.
- Board of Engineers for Rivers and Harbors.
- Office of Public Buildings and Grounds.
- United States Engineer Office.
- Mississippi River Commission.
- California Débris Commisson.

Office of the Chief of Ordnance.
Office of the Chief Signal Officer.
Office of the Chief of Air Service.
Bureau of Insular Affairs.
- Philippine Government.
- Porto Rico Government.
- Dominican customs receivership.

Militia Bureau.
Office of Chief of Chemical Warfare Service.
Inland Waterways Corporation.
War Credits Board.
The Army War College.
War Transactions Board.

IV. Department of Justice

Solicitor General.
Assistant Attorney General in charge of claims against the United States.
Public Lands Division.
Admiralty, finance, etc.
Antitrust Laws Division.
Criminal matters.
United States district attorneys.
Prohibition, taxation, commerce, etc.
Customs Division.
Bureau of Investigation.
Superintendent of prisons.
Attorney in charge of pardons.
United States marshals.
Departmental solicitors.

V. Post Office Department

First Assistant Postmaster General.
- Division of Post Office Service.
- Division of Postmasters' Appointments.
- Division of Post Office Quarters.
- Division of Motor Vehicle Service.
- Division of Dead Letters and Dead Parcel Post.

Second Assistant Postmaster General.
- Division of Railway Adjustments.
- Division of Foreign Mails.
- Division of Railway Mail Service.
- Division of Air Mail Service.

Third Assistant Postmaster General.
- Division of Finance.
- Division of Money Orders.

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Third Assistant Postmaster General—Continued.
- Division of Classification.
- Division of Stamps.
- Division of Registered Mails.
- Division of Postal Savings.

Fourth Assistant Postmaster General.
- Division of Rural Mails.
- Division of Equipment and Supplies.
- Division of Topography.
- Mail-Equipment Shops.

Office of the Comptroller.

VI. Department of the Navy

Office of Naval Operations.
- War Plans Division.
- Ship Movements Division.
- Intelligence Division.
- Communication Division.
- Material Division.
- Naval Districts Division.
- Policy and Liaison Section.
- Inspection Division.
- Fleet Training Division.
- Historical Section.

Bureau of Navigation.
- Naval Observatory.
- Hydrographic Office.

Bureau of Yards and Docks.
Bureau of Ordnance.
Bureau of Construction and Repair.
Bureau of Engineering.
Bureau of Supplies and Accounts.
Bureau of Medicine and Surgery.
Bureau of Aeronautics.
Office of the Judge Advocate General.
Naval Consulting Board.
Compensation Board.
General Board.
Board of Medical Examiners.
Naval Examining Board.
Naval Retiring Board.
Naval Dispensary.
Navy Yard and Station.
Naval Medical School.
Naval Hospital.
Attendance on officers.
Board for Examination of Medical Officers.
Board for Examination of Dental Officers.
Headquarters United States Marine Corps.
Marine Barracks.

VII. Department of the Interior

General Land Office.
Office of Indian Affairs.
Bureau of Pensions.
Bureau of Education.
Geological Survey.
Bureau of Reclamation.
National Park Service.
St. Elizabeths Hospital.
Howard University.
Board of Indian Commissioners.
Freedmen's Hospital.
The Alaska Railroad.
War Minerals Relief Commission.

VIII. Department of Agriculture

Secretary of Agriculture.
Assistant Secretary.

Director of Scientific Work.
Director of Regulatory Work.
Director of Extension Work.
Director of Information.
Director of Personnel and Business Administration.
Solicitor.
Weather Bureau.
Bureau of Agricultural Economics.
Bureau of Animal Industry.
Bureau of Plant Industry.
Forest Service.
Bureau of Chemistry.
Bureau of Soils.
Bureau of Entomology.
Bureau of Biological Survey.
Bureau of Public Roads.
Bureau of Home Economics.
Bureau of Dairy Industry.
Fixed Nitrogen Research Laboratory.
Office of Experiment Stations.
Office of Cooperative Extension Work.
Library.
Federal Horticultural Board.
Insecticide and Fungicide Board.
Packers and Stockyards Administration.
Grain Futures Administration.

IX. Department of Commerce

Division of Publications.
Bureau of the Census.
Bureau of Foreign and Domestic Commerce.
Bureau of Standards.
Bureau of Fisheries.
Bureau of Lighthouses.
Coast and Geodetic Survey.
Bureau of Navigation.
Steamboat Inspection Service.
Patent Office.
Bureau of Mines.

X. Department of Labor

Division of Conciliation.
Division of Publications and Supplies.
Bureau of Labor Statistics.
Bureau of Immigration.
Children's Bureau.
Bureau of Naturalization.
Women's Bureau.
United States Employment Service.
Bureau of Industrial Housing and Transportation.

XI. Independent Establishments

Library of Congress.
    Copyright Office.
Government Printing Office.
    Superintendent of Documents.
The Smithsonian Institution.
    National Museum.
    National Gallery of Art.
    Freer Gallery of Art.
    International Exchange Service.
    Bureau of American Ethnology.
    Astrophysical Observatory.
    National Zoological Park.
    International Catalogue of Scientific Literature.
National Academy of Sciences.
    National Research Council.

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The Pan American Union.
General Accounting Office.
Interstate Commerce Commission.
United States Railroad Labor Board.
Civil Service Commission.
United States Bureau of Efficiency.
Federal Reserve Board.
Federal Trade Commission.
United States Shipping Board.
United States Shipping Board Emergency Fleet Corporation.
United States Railroad Administration.
United States Council of National Defense.
The Joint Board.
The Aeronautical Board.
Board of Tax Appeals.
War Finance Corporation.
Alien Property Custodian.
United States Tariff Commission.
United States Employees' Compensation Commission.
National Screw Thread Commission.
United States Veterans' Bureau.
Federal Board for Vocational Education.
The Panama Canal.
Board of Road Commissioners for Alaska.
Commission on Navy Yards and Naval Stations.
American National Red Cross.
National Advisory Committee for Aeronautics.
The International Joint Commission.
The International Boundary Commission, United States, Alaska, and Canada.
International Boundary Commission, United States and Mexico.
Board of Surveys and Maps of the Federal Government.
The United States Section of the Inter-American High Commission.
Federal Power Commission.
United States Geographic Board.
Rock Creek and Potomac Parkway Commission.
The Commission of Fine Arts.
Washington National Monument Society.
The Congressional Club.
Arlington Memorial Amphitheater Commission.
Botanic Gardens.
American and British Claims Arbitration.
Mixed Claims Commission, United States and Germany.
National Home for Disabled Volunteer Soldiers.
United States Soldiers' Home.
Columbia Institution for the Deaf.
Pan American Sanitary Bureau.
Superintendent of the State, War, and Navy Department Buildings.
World War Foreign Debt Commission.
Federal Narcotics Control Board.
American Battle Monuments Commission.
Personnel Classification Board.
Washington City Post Office.
Federal coordinating agencies:
- Federal Purchasing Board.
- Federal Liquidation Board.
- Coordination of Motor Transport, District of Columbia.
- Federal Traffic Board.
- Federal Specifications Board.
- Interdepartmental Board of Contracts and Adjustments.
- Federal Real Estate Board.
- Permanent Conference on Printing.
- Interdepartmental Board on Simplified Office Procedure.

UNITED STATES DEPARTMENT OF AGRICULTURE

Organization

Secretary of Agriculture	W. M. Jardine.
Assistant Secretary	R. W. Dunlap.
Assistant to Secretary	F. M. Russell.
Director of Scientific Work	A. F. Woods.
Director of Regulatory Work	W. G. Campbell.
Director of Extension Work	C. W. Warburton.
Director of Information	N. A. Crawford.
Director of Personnel and Business Administration	W. W. Stockberger.
Solicitor	R. W. Williams.
Weather Bureau	C. F. Marvin, *Chief.*
Bureau of Agricultural Economics	Lloyd S. Tenny, *Chief.*
Bureau of Animal Industry	J. R. Mohler, *Chief.*
Bureau of Plant Industry	W. A. Taylor, *Chief.*
Forest Service	W. B. Greeley, *Chief.*
Bureau of Chemistry	C. A. Browne, *Chief.*
Bureau of Soils	Milton Whitney, *Chief.*
Bureau of Entomology	L. O. Howard, *Chief.*
Bureau of Biological Survey	E. W. Nelson, *Chief.*
Bureau of Public Roads	T. H. MacDonald, *Chief.*
Bureau of Home Economics	Louise Stanley, *Chief.*
Bureau of Dairy Industry	C. W. Larson, *Chief.*
Fixed Nitrogen Research Laboratory	F. G. Cottrell, *Director.*
Office of Experiment Stations	E. W. Allen, *Chief.*
Office of Cooperative Extension Work	C. B. Smith, *Chief.*
Library	Claribel R. Barnett, *Librarian.*
Federal Horticultural Board	C. L. Marlatt, *Chairman.*
Insecticide and Fungicide Board	J. K. Haywood, *Chairman.*
Packers and Stockyards Administration	John T. Caine III, *in Charge.*
Grain Futures Administration	J. W. T. Duvel, *in Charge.*

Duties and Functions

Secretary of Agriculture.—The Secretary of Agriculture is charged with the work of promoting agriculture in its broadest sense. He exercises general supervision and control over the affairs of the department and formulates and establishes the general policies to be pursued by its various branches and offices. These activities include investigations of the production, marketing, and utilization of crops and livestock, and control of the diseases and insect pests to which they are subject; maintenance of nation-wide weather service, crop and livestock estimating, and market-reporting services; administration of the national forests; and the enforcement of nearly 40 regulatory laws, among which are the packers and stockyards, future trading, and meat-inspection acts. He also administers the appropriations for Federal-aid highway and forest-road construction and the Federal grants to State colleges for agricultural extension and research work. The Secretary of Agriculture

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serves as a member of the War Finance Corporation, Federal Board for Vocational Education, Federal Power Commission, and Rock Creek and Potomac Parkway Commission.

Assistant Secretary.—The Assistant Secretary of Agriculture assists the Secretary in the direction and general administration of the affairs of the department, and in the absence of the Secretary becomes the Acting Secretary of Agriculture.

Assistant to Secretary.—The Assistant to Secretary assists the Secretary in all lines of administrative activities.

Director of Scientific Work.—The Director of Scientific Work coordinates all department scientific work and all research work of the bureaus and offices. The Office of Experiment Stations, which is attached to this branch, exercises the supervision provided by law over the work and expenditures of the State agricultural experiment stations, serving as a general clearing house for the national system and assisting in various ways to promote its efficiency; it supervises the work and expenditures of the agricultural experiment stations maintained by the department in Alaska, Hawaii, Porto Rico, Guam, and the Virgin Islands, and compiles and disseminates information regarding the progress of agricultural research through the Experiment Station Record and other publications.

Director of Regulatory Work.—The Director of Regulatory Work coordinates all department regulatory work and all the regulatory work of the bureaus and offices.

Director of Extension Work.—The Director of Extension Work coordinates all department extension work and all the extension work of the bureaus and offices. Attached to this branch is the Extension Service, which is composed of the Office of Cooperative Extension Work, Office of Exhibits, Office of Motion Pictures, Office of Demonstrations on Reclamation Projects, and Office of Agricultural Instruction. The Office of Cooperative Extension Work represents the Secretary of Agriculture in his relations with the State agricultural colleges, under the acts of Congress granting funds for these institutions for cooperative extension work in agriculture and home economics, and in carrying out the provisions of acts of Congress making appropriations to this department for farmers' cooperative demonstration work, for studies relating to courses in agricultural schools, and for farmers' institutes. All extension work of the department clears through this service.

Director of Information.—The Office of Information was formed by the Secretary to handle all the publications and informational policies and activities, including the editing, illustrating, and printing of publications, and the preparation of material for the press and for radio broadcasting. It coordinates the informational activities of the bureaus and offices, conducts the business of the department with the Public Printer, the Congressional Joint Committee on Printing, and the Permanent Joint Conference on Printing, and administers the regulations regarding publication of articles by department workers.

Director of Personnel and Business Administration.—The work of the various offices attached to the Office of the Secretary and engaged in personnel and other branches of business administration is carried on by the Office of Personnel and Business Administration. This change was made in the interest of efficiency and economy and relieves the Secretary of many details. This office operates through two major branches; one handles personnel matters and the other general business matters of the department. The director cooperates closely with the other directors of the department and with the chiefs

of bureaus and offices. This office brings together under one head the (1) administration of personnel, (2) salary classification, (3) inspection, (4) the office of chief clerk and the section of accounts serving units of the Office of the Secretary, (5) purchases and sales, (6) traffic management, (7) accounts and disbursements, and (8) the budget and finance work.

Solicitor.—The Solicitor is the legal adviser of the Secretary and the heads of the several branches of the department. He directs and supervises all law work of the department.

Weather Bureau.—The Weather Bureau has charge of the forecasting of the weather; the issue and display of weather forecasts, and storm, cold-wave, frost, and flood warnings; the gauging and reporting of river stages; the maintenance and operation of the United States Weather Bureau telegraph and telephone lines; the collection and transmission of marine intelligence for the benefit of commerce and navigators; the reporting of temperature and rainfall conditions for agricultural interests; and the taking of such meteorological observations as may be necessary to determine and record the climatic conditions of the United States, including investigations in aerology in the aid of aviation, in seismology, and in volcanology.

Bureau of Agricultural Economics.—The Bureau of Markets and Crop Estimates and the Offices of Farm Management and Farm Economics were united in one bureau on July 1, 1922, by the act making appropriations for the Department of Agriculture for the fiscal year 1923. This bureau conducts investigations in the costs of production and marketing, farm organization, farm financial relations, farm labor, agricultural history and geography, land economics, and the problems of rural life. The bureau also acquires and disseminates information regarding the marketing and distributing of farm and nonmanufactured food products, and collects, compiles, summarizes, interprets, and makes public statistical data relating to agricultural production. Studies are made of marketing methods, conditions, and costs, with regard to the standardization, transportation, handling, and storage of agricultural products. Demonstration work is conducted in connection with these studies. Reports are issued by the bureau which contain information on the supply, commercial movement, disposition, and market prices of grains, cotton, fruits and vegetables, livestock and meats, dairy and poultry products, and hay, feed, and seed. Information is also procured and published with regard to the supply of and demand for certain agricultural products in foreign countries. Summaries and analyses covering this information are published in the weekly "Crops and Markets," which embodies current statistics relating to the acreage, yield, condition, and production of crops, numbers of livestock, and value of farm products. Other special reports are issued at intervals. A market inspection service on fruits and vegetables is now available at many of the principal producing and receiving centers of the country and on butter at five of the principal terminal markets. Regulatory work is performed in connection with the enforcement of the United States cotton futures act, the United States grain standards act, the standard container act, and in connection with the administration of the United States warehouse act. Center Market, in the city of Washington, is also operated by this bureau.

Bureau of Animal Industry.—The Bureau of Animal Industry has charge of the work of the department relating to the livestock industry, with the exception of dairying. It enforces the laws passed by Congress to control and

eradicate animal diseases and parasites. The meat inspectors of this bureau are located in the important livestock centers and inspect all meat to see that it is free from disease and fit to eat. It helps the farmers of the United States to raise better livestock and is in charge of the extensive campaign to replace scrub livestock with purebreds. It has quarantine stations at seaports and along the borders of the country that inspect animals received from foreign lands to prevent introduction of foreign diseases and livestock pests. It has charge of extensive lines of investigation work and has livestock experiment stations located throughout the country.

Bureau of Dairy Industry.—The Bureau of Dairy Industry investigates problems relating to the dairy industry, under the following general projects: Bacteriology and chemistry of milk; breeding and nutrition of dairy cattle; dairy cattle management; dairy sanitation; dairy plant management; market milk; the manufacture of dairy products and by-products; and the introduction into the field of new principles and methods of dairying.

Bureau of Plant Industry.—The Bureau of Plant Industry studies plant life in all its relations to agriculture. The scientific work of the bureau is divided into 30 distinct groups, over each of which is placed a scientifically trained officer, who reports directly to the chief and associate chief of the bureau. The work of the bureau is conducted on the project plan, the investigations under each of the offices being arranged by group projects consisting of closely related lines of work, and each group project being further divided into projects.

Forest Service.—The Forest Service is concerned with the production and utilization of the forest crops of the United States. The work involves the following general functions: The administration and protection of the 146 national forests whose total area is over 157,000,000 acres; investigations of the problems of timber growing and protection, wood properties and the manufacture and economical utilization of wood and wood products, and forest economics; cooperation with State, municipal, and private owners of forest lands in the protection and proper use of their resources; and dissemination of information about the various phases of forestry and its relation to the public welfare, which is done by publications, lectures, exhibits, pictures, demonstrations, and personal conferences. The machinery for carrying on this work is composed of the general administrative offices at Washington, D. C., eight districts in immediate charge of the national forests, eight forest experiment stations, three grazing experiment stations, and the Forest Products Laboratory at Madison, Wis. In the headquarters and district offices are the following branches: Finance and accounts, operation, forest management, grazing, lands, research, engineering, and public relations.

Bureau of Chemistry.—The Bureau of Chemistry conducts investigations relating to the application of chemistry to agriculture; develops methods for the utilization of agricultural crops; makes biological investigations of food and drug products, including the physiological effects of such products on the human organism; develops methods for the manufacture of table sirup and sugar; investigates the composition, action, and application of insecticides and fungicides; develops methods for the prevention of plant-dust explosions and fires in cotton gins and cotton-oil mills; investigates the weighing, grading, handling, transportation, and uses of rosin and turpentine; conducts experiments on the utilization, for coloring, medicinal, and technical purposes, of raw materials grown or produced in the United States; enforces the act to prevent the importation of impure and un-

wholesome tea; and enforces the food and drugs act, commonly known as the pure food law.

Bureau of Soils.—The Bureau of Soils investigates the relation of soils to climate and organic life; studies the texture and composition of soils in field and laboratory; maps the soils; studies the cause and means of preventing the rise of alkali in the soils of irrigated districts; the relations of soils to seepage and drainage conditions; and the fertilizer resources of the country.

Bureau of Entomology.—The Bureau of Entomology studies insects in their economic relations to agriculture and agricultural products and to the health of man and animals; experiments with the introduction of beneficial insects; makes tests with insecticides and insecticide machinery; and identifies insects sent in by inquirers.

Bureau of Biological Survey.—The Bureau of Biological Survey studies the distribution and habits of native wild life, makes biological surveys of areas, and maps the natural life zones of the country; investigates the food habits and relation of wild birds and animals to agriculture, horticulture, forestry, and stock raising with the view to conservation of the useful and control of the harmful species; devises methods and conducts campaigns on Federal lands and in cooperation with the States for the control and eradication of predatory animals, destructive rodents, and other injurious forms; maintains a station for experimental investigation of breeding, feeding, and management problems affecting the production of fur-bearing animals, and studies the parasites and diseases to which fur bearers are subject when reared in captivity; investigates the care, management, and production of reindeer in Alaska, and administers Federal laws relating to big-game and bird reservations, to migratory game, non-game, and insectivorous birds, to importations of foreign wild birds and animals, to interstate commerce in wild birds and game, and to Alaskan land fur-bearing animals.

Bureau of Public Roads.—The Bureau of Public Roads administers the Federal-aid road act, under which the Government cooperates with the States in improvement of roads of the Federal-aid highway system and national-forest roads; studies systems of road management, administration and finance, methods of road construction and maintenance; tests road materials; conducts research with its own forces solely and in cooperation with colleges, experiment stations, and State highway departments to determine the causes of road depreciation and to devise better methods of road design; investigates methods of land irrigation and drainage; studies farm power problems; and offers an advisory service in connection with all matters concerned with the application of engineering and architectural principles to the farm and farm home.

Bureau of Home Economics.—The Bureau of Home Economics conducts investigations and disseminates information on foods and nutrition, economic problems of the home, clothing and textiles, and housing and equipment. Under the first of these divisions, studies are made of such questions as food selection and meal planning from the standpoint of health and economy, dietary studies, home methods of food preservation, utilization of new food products, and vitamin content of foods. Under the second, standards and costs of living, family budgets and accounts, economic value of housework, evaluation of housekeeping services, and economic relationships within the family. The textile and clothing division is working on textile composition and construction from the standpoint of the consumer, simplified methods of clothing construction, costume design

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and other related art problems, hygiene of clothing, and renovation and care of clothing and household textiles. General aspects of the housing situation, house planning for health and convenience, and kitchen arrangement and equipment are given attention by the housing and equipment division.

Fixed Nitrogen Research Laboratory.—The principal function of the Fixed Nitrogen Research Laboratory consists in conducting researches on methods of fixing the nitrogen of the atmosphere for agricultural, industrial, and military purposes. This includes the improvement of the existing processes (cyanamide, haber, arc, and cyanide), the discovery and development of new processes, and the study of the transformation of nitrogen compounds from one form to another.

Office of Experiment Stations.—(See Director of Research Work.)

Office of Cooperative Extension Work.—(See Director of Extension Work.)

Library.—The library of the department is scientific, technical, and statistical in character. It comprises approximately 175,000 volumes and pamphlets, exclusive of the Weather Bureau collection which contains 30,000 volumes. Approximately 3,200 periodicals are received currently, exclusive of serials such as annual reports and proceedings. A dictionary catalogue is maintained which contains half a million cards and forms an extensive bibliography of the literature of agriculture and the related sciences. Printed cards for cataloguing the publications of the department are prepared by the library and can be obtained at a small cost from the Library of Congress. The library lends its books for purposes of research to various libraries and institutions throughout the country, but especially to State colleges and experiment stations which have a close relation to the department.

Federal Horticultural Board.—The Federal Horticultural Board, created August 21, 1912, assists the Secretary of Agriculture in the enforcement of the plant quarantine act of August 20, 1912. It is composed of five members, two representing the Bureau of Entomology, two the Bureau of Plant Industry, and one the Forest Service. The board now enforces some 22 quarantine and restrictive orders prohibiting or regulating the entry of foreign plants and plant products and some 15 domestic quarantines controlling the interstate movement of plants, plant products, and other articles.

Insecticide and Fungicide Board.—The Insecticide and Fungicide Board, created December 22, 1910, assists the Secretary of Agriculture in the enforcement of the insecticide act of 1910. It is composed of four members, who represent the Bureaus of Chemistry, Plant Industry, Entomology, and Animal Industry, respectively. Working under the direction of the board are groups of chemists, bacteriologists, and microscopists who analyze samples, and entomologists, plant pathologists, and other scientists who make laboratory and field tests of official samples to determine the accuracy of efficiency claims. A force of inspectors is distributed over the United States for the purpose of inspecting and sampling shipments of products that are within the scope of the law and for making necessary investigations.

Packers and Stockyards Administration.—The Packers and Stockyards Administration was created under the act of August 15, 1921, known as the packers and stockyards act of 1921, and assists the Secretary of Agriculture in the enforcement of that law.

Grain Futures Administration.—The Grain Futures Administration was created under the act of September 21, 1922, known as the grain futures act, and assists the Secretary of Agriculture in the enforcement of that law.

History of Department

The Department of Agriculture is the branch of the United States Government charged with the duties of fostering agriculture in all its phases. It had its origin in the foresightedness of George Washington, who in 1793 asked Congress to make arrangements to promote agriculture.

In 1836, without any definite authority of law, an agricultural division was established in the Patent Office. An appropriation of $1,000 was made three years later for "collecting and distributing seeds, prosecuting agricultural investigations, and procuring agricultural statistics." The money was taken from the Patent Office fund and the work was done under the Commissioner of Patents, who was an official in the Department of State. In his report, made in 1841, the commissioner stated that 30,000 packages of seed had been distributed during the year and that agricultural statistics as gathered in the census were being prepared for publication. This arrangement continued until 1849 when the Department of the Interior was established and the Patent Office, with its agricultural work, became a part of it.

The law setting up an independent department was passed May 15, 1862. The United States Agricultural Society, organized in 1852 and meeting in Washington annually from that time until 1860, had been active in urging the establishment of a department. It was largely instrumental in creating the public opinion which made possible the practical realization of George Washington's idea. It is noteworthy that in the same year, June 19, 1862, the Morrill Act was passed, which provided for the establishment of State agricultural colleges.

Isaac Newton, first Commissioner of Agriculture, 1862–1867; native of New Jersey but settled in Pennsylvania; farmer. Given full control of the property of the Division of Agriculture in the Patent Office and conducted his work independently of the Department of the Interior. Plot of ground, now the beautiful department grounds, used as experimental farm. Chemist and entomologist appointed to conduct research work. An office was established which later became the Weather Bureau.

Gen. Horace Capron, Commissioner of Agriculture, 1867–1871; native of New York but moved to Maryland; then to Illinois in 1854; farmer and breeder of Devon cattle. Brigadier general in Union Army. Established a system of exchanging seeds and plants with foreign countries. The main building, which to-day is used as the administration building, was completed and occupied during his term of office. Division of Botany established in 1868.

Judge Frederick Watts, Commissioner of Agriculture, 1871–1877; Pennsylvania; lawyer, but in 1858 abandoned law for farming. First president of Pennsylvania Agricultural Society. Upon taking office Commissioner Watts found in operation the Divisions of Chemistry, Garden and Grounds, Entomology, Statistics, and Botany. Division of Microscopy established in 1871. Forest investigations were established in 1877 and were the beginning of the Forest Service. Weather reporting work was transferred

to the War Department. Division of Statistics had 3,000 voluntary correspondents and an appropriation of $15,000.

William G. LeDuc, Commissioner of Agriculture, 1877–1881; Minnesota; farmer. Was opposed to indiscriminate distribution of common seeds. Special appropriation of $10,000 obtained to investigate diseases among hogs and cattle. Pleuropneumonia among cattle had gained a strong foothold throughout the country. Investigation of the history and habits of insects started with an appropriation of $10,000. Allotment of funds made for irrigation work for experiments with artesian wells. Work was continued in the making of sugar from sorgo (sweet sorghum) and beets. A farm was leased to conduct investigations in tea culture with an appropriation of $20,000.

Dr. George B. Loring, Commissioner of Agriculture, 1881–1885; Massachusetts; educated as a physician, but beginning in 1857 he devoted his time to farming. At the start of his term the work in the department consisted of investigations on tea culture, sugar making from sorgo and beets, vegetable and animal fibers, economic insects, irrigation by the use of artesian wells, and diseases of domestic animals. Sugar-making experiments from sorgo and work on artesian wells were ended with disappointing results. Veterinary station was established in Washington, and the control of quarantine against diseased animals was transferred from the Treasury Department to the commissioner. Bureau of Animal Industry started in 1884 with an appropriation of $150,000. Division of Statistics was reorganized in order to use a better system of crop reporting. European agency was established to collect information showing the demand for American products. Two million packages of seeds distributed in 1883.

Norman J. Colman, Commissioner of Agriculture, 1885–1889; New York; educated in law; strong inclination toward rural pursuits. Largely through the efforts of the National Grange, the department became one of the executive branches of the Government on February 8, 1889, and Commissioner Colman was appointed by President Cleveland as the first Secretary of Agriculture. Office of Experiment Stations was established by the Hatch Act in 1887. Division of Pomology and Division of Ornithology and Mammalogy were also established. A study of public highways, investigations of the rapid decrease in forest areas, and the planting of trees on the plains were started.

Jeremiah M. Rusk, Secretary of Agriculture, 1889–1893; Ohio; farmer. He divided the work of the department into two main classes: The Secretary took immediate charge of the executive work, and the scientific work was administered by the Assistant Secretary, the latter office having just been created. A Division of Records and Editing, which later became the Division of Publications, was established for the purpose of editing and supervising publications. Farmers' Bulletins were started by Secretary Rusk. Quarantine regulations against Texas fever among cattle were placed under Federal control. The Weather Bureau was transferred from the War Department to the Department of Agriculture.

J. Sterling Morton, Secretary of Agriculture, 1893–1897; native of New York but later moved to Nebraska. Author of Arbor Day legislation—adopted by 42 States—which sets aside one day each year to be made a public holiday and be devoted to tree planting. Division of Agrostology was formed. Consular agents throughout the world were requested to send seeds of new forage plants to the department. Division of Soils was formed as a part of the Weather Bureau. Office of Road Inquiry

was established. Division of Microscopy was abolished. Dairy Division was formed in 1895. Competitive examinations for filling positions in the civil service were started.

James Wilson, Secretary of Agriculture, 1897–1913; Iowa; farmer. During his administration Congress constantly increased the appropriations, from $2,000,000 in 1897 to $20,000,000 in 1913. Several new lines of work were introduced in the Bureau of Plant Industry. The Forest Service was organized, and the Divisions of Chemistry, Soils, Entomology, Statistics, and Biological Survey were made bureaus. Numerous investigations involving plant and animal life were started. The department offices in 1903 occupied more than 3 acres of floor space. A new agricultural building was planned, and in 1908 the east and west wings were completed and occupied. Three hundred acres from the Arlington Estate in Virginia and a tract of land at Beltsville, Md., were procured for the Bureaus of Plant Industry and Animal Industry, respectively.

David F. Houston, Secretary of Agriculture, 1913–1919; Texas; college executive and professor of political science. The war created many perplexing problems for the American farmer. Food production was increased, and additional provision was made to stimulate the raising of meat animals. The Smith-Lever Act, passed May 8, 1914, provided for cooperative extension work in agriculture and home economics between the department and the State agricultural colleges. The Federal-aid road act, Federal reserve act, Federal farm loan act, grain standards act, and warehouse act, all passed during this administration, benefited the farmer in a number of ways. War operations were aided by every bureau in the department.

Edwin T. Meredith, Secretary of Agriculture, 1919–1921; Iowa; publisher; farmer. He held office during the worst period of depression in the history of American agriculture. Attention was given to the world aspect of American farming, and foreign market information was collected and made available to the farmers. The Bureau of Crop Estimates and Bureau of Markets were combined. The market-reporting service was extended, and the use of radio in sending out information was tried and adopted. Warfare against plant diseases and insects was carried on vigorously.

Henry C. Wallace, Secretary of Agriculture, 1921–1924; Iowa; editor and publisher; farmer. Farming continued in the depression as a result of the war. The activities of the department were so directed as to be of the greatest possible service in the task of restoring agriculture to a prosperous basis. One of the important steps taken was to provide for the offices of Director of Scientific Work, Director of Regulatory Work, and Director of Extension Work. The directors are charged with the coordination of all scientific, regulatory, and extension work of the department. For the first time this brought the supervision of each line of work under a single directing head. The Offices of Farm Management and Farm Economics and the Bureau of Markets and Crop Estimates were combined into the Bureau of Agricultural Economics. The States Relations Service, Director of Information, and Division of Publications, as such, were abolished. The Office of Experiment Stations was assigned to the Office of the Director of Scientific Work. The new Extension Service, composed of the Office of Cooperative Extension Work, Office of Motion Pictures, and Office of Exhibits, was attached to the Office of the Director of Extension Work. The Office

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of Editorial and Distribution Work was created. In order that home-economics work might be strengthened, the Bureau of Home Economics was formed. Commodity councils, composed of various representatives of bureaus and offices, were formed to make comprehensive studies of the conditions that influence the profitable production of crops. Progress was made in the eradication of plant and animal diseases. Statistical work, as it related to crop and livestock production, was improved and broadened. Secretary Wallace died at Washington, D. C., October 25, 1924, the first Secretary of Agriculture to die while holding office.

Howard M. Gore, Secretary of Agriculture, 1924–1925; West Virginia; farmer and livestock producer. He was appointed Assistant Secretary of Agriculture on September 17, 1923, and became Acting Secretary on the death of Mr. Wallace. President Coolidge appointed him Secretary on December 4, 1924. Secretary Gore remained in the Cabinet until March 4, 1925, when he became Governor of West Virginia.

William M. Jardine, Secretary of Agriculture, 1925–——; Kansas; farmer and educator. Secretary Jardine was president of the Kansas State Agricultural College at the time of his appointment by President Coolidge and was a member of the President's Agricultural Conference which had reported its findings and suggestions just previous to his appointment. A short time after becoming Secretary he consolidated the business offices of the department in the interest of economy and greater efficiency, forming the Office of Personnel and Business Administration. He also brought about the formation of the Office of Information so that the publication, printing, and information work could be handled under one head, and placed the Office of Demonstrations on Reclamation Projects and Office of Agricultural Instruction under the Extension Service.

Laws

Tea Inspection Act.—Mar. 2, 1897 (29 Stat. 604). Amendments May 16, 1908, and May 31, 1920.

This act is designed to prevent the importation of any impure and unwholesome tea. It prohibits the importation of any merchandise as tea which is inferior, in purity, quality, or fitness for consumption, to the standards established in accordance with the provisions of the act, but allows the importation thereof or of tea waste, tea sifting, for the sole purpose of manufacturing caffeine or other chemical products whereby the original material is changed.

The text of the act and the regulations thereunder are published in United States Department of Agriculture Miscellaneous Circular 9.

Renovated Butter Act.—May 9, 1902, sec. 5 (32 Stat. 196).

This section requires a sanitary inspection of all factories and storehouses where process or renovated butter is manufactured or prepared for interstate or foreign commerce, and of all materials entering into the manufacture of the same; requires the distinctive marking of the finished product; and prohibits the interstate shipment or transportation and the exportation of such product made from deleterious or unwholesome materials, or not so labeled.

The text of these provisions and the regulations thereunder are published in Bureau of Dairying Order No. 1.

Food and Drugs Act.—June 30, 1906 (34 Stat. 768), amended Aug. 23, 1912, Mar. 3, 1913.

This act is designed to protect consumers against adulterated or misbranded food and drug products and its enforcement protects the manufacturer of such products against unfair competition. It prohibits the manufacture in the District of Columbia of, and interstate or foreign commerce in, adulterated or misbranded food or drugs; defines the terms "adulterated" and "misbranded"; provides for the condemnation, by process of libel, of adulterated and misbranded food and drugs shipped in interstate or foreign commerce or sold in the District of Columbia; and provides for the rejection of such articles when offered for import. By act of March 4, 1923 (42 Stat. 1500) butter is defined for the purposes of the food and drugs act.

The text of the food and drugs act and the regulations thereunder are publishtd in Office of the Secretary Circular 21.

Naval Stores Act.—Mar. 3, 1923 (42 Stat. 1435).

This act defines naval stores as spirits of turpentine and rosin. It establishes standards for spirits of turpentine and rosin; prohibits the shipment in commerce of such articles except under or by reference to the standards; requires that such articles comply with the standards; and prohibits misrepresentation and requires fair dealing in respect to the articles so defined.

The text of the act and the regulations thereunder are published in United States Department of Agriculture Miscellaneous Circular 22.

Alaska Game Law.—Jan. 13, 1925 (43 Stat. 739).

The purpose of this act is to protect and conserve big-game animals, land fur-bearing animals, and wild birds in Alaska. The act creates and provides for a resident commission, known as the Alaska Game Commission, for the enforcement of the act; authorizes members of the commission, game wardens, and other Federal officers and employees to make arrests and execute search warrants

in cases of violations of the act; provides for the seizure and forfeiture of all guns, traps, etc., used and of all animals and birds taken, in violation of the act; prohibits the taking, possessing, transporting, sale, or purchase of any big-game animal, land fur-bearing animal, or wild bird or nest or egg thereof, except under regulations of the Secretary of Agriculture; authorizes the Secretary of Agriculture, on advice of the commission, to determine when, to what extent, and by what means the animals and birds protected by the act may be taken, possessed, transported, bought, or sold, and to adopt regulations permitting and governing the same; subject to express prohibitions, restrictions, and limitations prescribed by the act; and provides for hunting and trapping licenses, the registration and licensing of guides, and the licensing of fur-farmers and dealers.

The text of this act and the regulations thereunder are published in Service and Regulatory Announcements of the Department, A. G. C. 1.

Bird Reservation Act.—Mar. 4, 1909 (35 Stat. 1104), and sec. 84, Penal Code, Apr. 15, 1924.

This act prohibits the hunting, trapping, capture, willful disturbing, or killing of any bird or wild animal, or the destruction of the eggs of birds on Federal bird or game reservations, except under regulations of the Secretary of Agriculture, and makes it unlawful willfully to injure, molest, or destroy property on such lands.

May be found in annual farmers' bulletin on game laws.

Importation of Plumage.—Tariff act of Apr. 21, 1922 (42 Stat. 927), par. 1419.

This paragraph prohibits the importation of birds of paradise, aigrettes, egret plumes, and feathers, quills, skins, or parts of skins of wild birds, either raw or manufactured, unless for scientific or educational purposes, which if found in the United States after the passage of this act, except such as are in actual use for personal adornment or for scientific or educational purposes, shall be presumed to have been unlawfully imported and subject to seizure.

May be found in annual farmers' bulletin on game laws.

Importation of Game-Bird Eggs for Propagation.—Tariff act of Apr. 21, 1922 (42 Stat. 927), par. 1569.

This paragraph prohibits the importation of the eggs of birds, except that the eggs of game birds may be imported free under regulations of the Secretary of Agriculture for propagating purposes; specimens may also be imported free for scientific collections.

May be found in annual farmers' bulletin on game laws.

Migratory Bird Treaty Act.—July 3, 1918 (40 Stat. 755).

This act gives effect to the convention between the United States and Great Britain for the protection of migratory birds, concluded at Washington, August 16, 1916, and makes it unlawful, except as permitted by regulations adopted by the Secretary of Agriculture and approved by the President, to hunt, take, capture, kill, possess, sell, purchase, deliver for shipment, ship, etc., any of said birds, or any part, nest, or egg of any such bird, or to ship or carry by any means whatever in interstate or foreign commerce, any bird, or any part, nest, or egg thereof, taken or shipped contrary to the laws of the State in which it was taken or shipped, or carried.

May be found in annual farmers' bulletin on game laws.

Regulation of Interstate Commerce in Game.—(Lacey Act), May 25, 1900 (31 Stat. 187), and Mar. 4, 1909 (35 Stat. 1137).

This act prohibits the importation of injurious birds and animals; regulates the importation of other wild animals and birds, and also prohibits the interstate shipment of wild birds and animals killed or shipped in violation of State laws (superseded by sec. 4 of the migratory-bird treaty act in so far as it relates to birds).

May be found in annual farmers' bulletin on game laws.

Upper Mississippi River Wild Life and Fish Refuge Act.—June 7, 1924 (43 Stat. 650).

This act provides for the acquisition of lands and water along the Mississippi River between Rock Island, Ill., and Wabasha, Minn., for a refuge for wild birds, game animals, fur-bearing animals, and for the conservation of plant life and fish; and prohibits entering the refuge, destroying or injuring any wild bird, or the nest or egg thereof, game animal, fur-bearing animal, fish, plant life, or property thereon.

Wichita Game Refuge Act.—Jan. 24, 1905 (33 Stat. 614).

This act makes a game preserve of the Wichita National Forest, Okla., and prohibits the hunting, trapping, or killing of game animals or birds therein, except under regulations of the Secretary of Agriculture.

Insecticide Act.—Apr. 26, 1910 (36 Stat. 331).

This act is designed to protect farmers, fruit growers, etc., and stock and poultry raisers from fraudulent insecticides and fungicides used to prevent, destroy, repel, or mitigate insects or fungi and to protect the general public from fraudulent household insecticides and disinfectants. It defines the terms "insecticide," "Paris green," "lead arsenate," and "fungicide"; prohibits the manufacture and sale in the District of Columbia and territories and interstate or foreign shipments of "adulterated" or "misbranded" insecticides and fungicides; defines the terms "adulterated" and "misbranded" in such a way as to forbid false and misleading statements on labels and forbid the sale of insecticides that are injurious to the host plant; provides for the prosecution of shippers and manufacturers of adulterated and misbranded insecticides and fungicides and for the seizure of such articles; and provides for the rejection thereof when offered for import. See Office of the Secretary Circular 34, revised.

Honeybee Importation Act.—Aug. 31, 1922 (42 Stat. 833).

This act is designed to prevent the introduction and spread of diseases dangerous to adult honeybees. It provides for the reexport or destruction of imported adult honeybees, unless imported from countries in which the Secretary of Agriculture shall determine that no dangerous honeybee diseases exist, such importation to be under rules and regulations prescribed by the Secretary.

These rules specifically provide that all importation of adult honeybees shall be made through the Department of Agriculture to insure adequate inspection.

Land-Grant Colleges.—(Morrill Act) July 2, 1862 (12 Stat. L. 503); (Morrill Act) Aug. 30, 1890 (26 Stat. L. 417); (Nelson Amendment) Mar. 4, 1907 (34 Stat. L. 1256, 1281).

The Morrill Act of 1862 donated public land to be apportioned to each State, a quantity equal to 30,000 acres for each Senator and Representative in Congress, the entire proceeds of the sale of such lands to be applied toward the endowment, support, and maintenance of at least one college in each State where the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and mechanic arts, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life.

The Morrill Act of 1890 provided for the further endowment of land-grant colleges to the extent of $25,000 each year to each State to be obtained from the proceeds of public lands, and to be applied only to instruction in agriculture and mechanic arts, the English language, and the various branches of mathematical, physical, natural,

and economical science, with special reference to their applications in the industries of life and to the facilities of such instruction.

The Nelson Amendment of 1907 provided further endowment to the land-grant colleges to the extent of $50,000 each year to each State.

The text of these acts may be found in Department Circular 251.

Agricultural Experiment Station Acts.—(Hatch Act) Mar. 2, 1887 (24 Stat. 440); (Adams Act) Mar. 16, 1906 (34 Stat. 63); (Purnell Act) Feb. 24, 1925 (43 Stat. 970).

The Hatch Act provided an annual appropriation of $15,000 to establish in connection with the land-grant college in each State an agricultural experiment station for the purpose of promoting "scientific investigation and experiment respecting the principles and applications of agricultural science." The Adams Act provided an additional $15,000 annually for each State for "conducting original researches or experiments bearing directly on the agricultural industry of the United States." The Purnell Act gives to each State in addition to the $30,000 provided by the Hatch and Adams Acts $20,000 for the year ended June 30, 1926, with an annual increase of $10,000 until the total fund from this source amounts to $60,000 a year, for experiments and investigations "bearing directly on the production, manufacture, preparation, use, distribution, and marketing of agricultural products * * * and such economic and sociological investigations as have for their purpose the development and improvement of the rural home and rural life." The total Federal aid to the agricultural experiment stations will at maturity of the Purnell Act amount to $4,320,000 annually.

The text of these acts may be found in Department Circular 251.

Smith-Lever Act.—May 8, 1914 (38 Stat. L. 372).

An Act To provide for cooperative agricultural extension work between the agricultural colleges in the several States receiving the benefits of an act of Congress approved July second, eighteen hundred and sixty-two, and of acts supplementary thereto, and the United States Department of Agriculture.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That in order to aid in diffusing among the people of the United States useful and practical information on subjects relating to agriculture and home economics, and to encourage the application of the same, there may be inaugurated in connection with the college or colleges in each State now receiving, or which may hereafter receive, the benefits of the act of Congress approved July second, eighteen hundred and sixty-two, entitled "An act donating public lands to the several States and Territories which may provide colleges for the benefit of agriculture and the mechanic arts" (Twelfth Statutes at Large, page five hundred and three), and of the act of Congress approved August thirtieth, eighteen hundred and ninety (Twenty-sixth Statutes at Large, page four hundred and seventeen and chapter eight hundred and forty-one), agricultural extension work which shall be carried on in cooperation with the United States Department of Agriculture: *Provided,* That in any State in which two or more such colleges have been or hereafter may be established the appropriations hereinafter made to such State shall be administered by such college or colleges as the legislature of such State may direct: *Provided further,* That, pending the inauguration and development of the cooperative extension work herein authorized, nothing in this act shall be

construed to discontinue either the farm managment work or the farmers' cooperative demonstration work as now conducted by the Bureau of Plant Industry of the Department of Agriculture.

SEC. 2. That cooperative agricultural extension work shall consist of the giving of instructions and practical demonstrations in agriculture and home economics to persons not attending or resident in said colleges in the several communities, and imparting to such persons information on said subjects through field demonstrations, publications, and otherwise; and this work shall be carried on in such manner as may be mutually agreed upon by the Secretary of Agriculture and the State agricultural college or colleges receiving the benefits of this act.

SEC. 3. That for the purpose of paying the expenses of said cooperative agricultural extension work and the necessary printing and distributing of information in connection with the same, there is permanently appropriated, out of any money in the Treasury not otherwise appropriated, the sum of $480,000 for each year, $10,000 of which shall be paid annually, in the manner hereinafter provided, to each State which shall by action of its legislature assent to the provisions of this act: *Provided*, That payment of such installments of the appropriation hereinbefore made as shall become due to any State before the adjournment of the regular session of the legislature meeting next after the passage of this act may, in the absence of prior legislative assent, be made upon the assent of the governor thereof, duly certified to the Secretary of the Treasury: *Provided further*, That there is also appropriated an additional sum of $600,000 for the fiscal year following that in which the foregoing appropriation first becomes available, and for each year thereafter for seven years a sum exceeding by $500,000 the sum appropriated for each preceding year, and for each year thereafter there is permanently appropriated for each year the sum of $4,100,000 in addition to the sum of $480,000 hereinbefore provided: *Provided further*, That before the funds herein appropriated shall become available to any college for any fiscal year plans for the work to be carried on under this act shall be submitted by the proper officials of each college and approved by the Secretary of Agriculture. Such additional sums shall be used only for the purposes hereinbefore stated, and shall be allotted annually to each State by the Secretary of Agriculture and paid in the manner hereinbefore provided, in the proportion which the rural population of each State bears to the total rural population of all the States as determined by the next preceding Federal census: *Provided further*, That no payment out of the additional appropriations herein provided shall be made in any year to any State until an equal sum has been appropriated for that year by the legislature of such State, or provided by State, county, college, local authority, or individual contributions from within the State, for the maintenance of the cooperative agricultural extension work provided for in this act.

SEC. 4. That the sums hereby appropriated for extension work shall be paid in equal semiannual payments on the first day of January and July of each year by the Secretary of the Treasury upon the warrant of the Secretary of Agriculture, out of the Treasury of the United States, to the treasurer or other officer of the State duly authorized by the laws of the State to receive the same; and such officer shall be required to report to the Secretary of Agriculture, on or before the first day of September of each year, a detailed statement of the amount so received during the previous fiscal year, and of its disbursement, on forms prescribed by the Secretary of Agriculture.

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SEC. 5. That if any portion of the moneys received by the designated officer of any State for the support and maintenance of cooperative agricultural extension work, as provided in this act, shall by any action or contingency be diminished or lost or be misapplied, it shall be replaced by said State to which it belongs, and until so replaced no subsequent appropriation shall be apportioned or paid to said State, and no portion of said moneys shall be applied, directly or indirectly, to the purchase, erection, preservation, or repair of any building or buildings, or the purchase or rental of land, or in college-course teaching, lectures in colleges promoting agricultural trains, or any other purpose not specified in this act, and not more than five per centum of each annual appropriation shall be applied to the printing and distribution of publications. It shall be the duty of each of said colleges annually, on or before the first day of January, to make to the governor of the State in which it is located a full and detailed report of its operations in the direction of extension work as defined in this act, including a detailed statement of receipts and expenditures from all sources for this purpose, a copy of which report shall be sent to the Secretary of Agriculture and to the Secretary of the Treasury of the United States.

SEC. 6. That on or before the first day of July in each year after the passage of this act the Secretary of Agriculture shall ascertain and certify to the Secretary of the Treasury as to each State whether it is entitled to receive its share of the annual appropriation for cooperative agricultural extension work under this act, and the amount which it is entitled to receive. If the Secretary of Agriculture shall withhold a certificate from any State of its appropriation, the facts and reasons therefor shall be reported to the President, and the amount involved shall be kept separate in the Treasury until the expiration of the Congress next succeeding a session of the legislature of any State from which a certificate has been withheld, in order that the State may, if it should so desire, appeal to Congress from the determination of the Secretary of Agriculture. If the next Congress shall not direct such sum to be paid, it shall be covered into the Treasury.

SEC. 7. That the Secretary of Agriculture shall make an annual report to Congress of the receipts, expenditures, and results of the cooperative agricultural extension work in all of the States receiving the benefits of this act, and also whether the appropriation of any State has been withheld, and if so, the reasons therefor.

SEC. 8. That Congress may at any time alter, amend, or repeal any or all of the provisions of this act.

Acts Regulating the Transportation of Livestock.—Animal quarantine act of May 29, 1884 (23 Stat. 31); Aug. 30, 1890 (26 Stat. 414); Mar. 3, 1891 (26 Stat. 833); Feb. 2, 1903 (32 Stat. 791); Mar. 3, 1905 (33 Stat. 1264).

These acts are designed to protect stock raisers, farmers, and others against the spread of contagious animal diseases. They authorize cooperation between the Department of Agriculture and the various States in suppressing contagious animal diseases; prohibit the interstate transportation or the importation of diseased animals; authorize the inspection and quarantine of imported animals and the inspection of animals for export, as well as the vessels carrying them; provide for the safe transportation and humane treatment of export animals; and authorize the establishment of a quarantine of any portion of the United States where contagious animal diseases are found to exist and prohibit the movement of livestock therefrom, except in the manner prescribed by the Secretary of Agriculture.

Acts of May 29, 1884, February 2, 1903, and March 3, 1905, and regulations thereunder are contained in B. A. I. Order 273.

Act of August 30, 1890, and regulations thereunder are contained in B. A. I. Order 281.

Regulations under act of March 3, 1891, are found in B. A. I. Order 264.

Free Importation of Purebred Animals.—Tariff act of Sept. 21, 1922 (42 Stat. 923), par. 1506.

This act is designed to assist farmers and stock raisers in procuring purebred animals for breeding and farm purposes. It allows free importation of purebred, pedigreed animals of a breed recognized and registered in the Department of Agriculture, when certified as such by the department.

Copy of this paragraph of the tariff act and the regulations thereunder will be found in B. A. I. Order 288.

Meat Inspection Act.—Agricultural appropriation act of Mar. 4, 1907 (34 Stat. 1260).

This act is designed to prevent the use in interstate or foreign commerce of unwholesome meat and meat food products. It provides for the inspection, before slaughter, of all animals and, after slaughter, of all meat and meat food products derived therefrom, intended for interstate or foreign commerce; provides for the proper labeling of carcasses, meats, and meat foods according as the same are found by inspection to be wholesome or unwholesome; and prohibits the movement in interstate or foreign commerce of carcasses, meats, or meat foods unless inspected, found wholesome, and so labeled. Supplementary to this act the tariff act of September 21, 1922 (42 Stat. 891), par. 706, prohibits the importation of unsound meat or meats not complying with the regulations of the Secretary of Agriculture.

The act and regulations thereunder are contained in B. A. I. Order 211, revised.

Packers and Stockyards Act.—Aug. 15, 1921 (42 Stat. 159).

This act is designed to prevent unfair and deceptive practices, or creating a monopoly, in interstate commerce in livestock and livestock products. It provides for the regulation of the trade practices of packers, stockyard owners, commission men, dealers, and buyers where such practices affect the current of interstate and foreign commerce in livestock and the manufacture of meats and meat food products and, in some circumstances, the preparation and marketing of dairy products, poultry, and poultry products.

A copy of this act and the rules and regulations promulgated thereunder are contained in Office of the Secretary Circular 156.

Tuberculous Animal Reimbursement Act.—Agricultural appropriation act of May 11, 1926.

This act provides for cooperation with States, counties, and municipalities in partial reimbursement of owners of tuberculous animals destroyed for the purpose of controlling and eradicating the disease of animal tuberculosis.

Copy of the same act, except the amount of money appropriated for its enforcement, and the regulations thereunder will be found in B. A. I. Order 282.

Twenty-Eight-Hour Law.—June 29, 1906 (34 Stat. 607).

This act is designed to provide humane treatment for animals shipped in interstate commerce. It prohibits the confinement in cars, boats, or vessels, during interstate transportation, of animals for a period longer than 28 consecutive hours, without unloading the animals in suitable pens for rest, water, and feeding for at least five consecutive hours. It permits extension of prohibited period to 36 hours under certain circumstances.

Copy of the act is found in B. A. I. Order 273.

Virus-Serum-Toxin Act.—Mar. 4, 1913 (37 Stat. 828).

This act is designed to protect purchasers and others against worthless or harmful viruses and serums used

in the treatment of domestic animals. It prohibits the sale in the District of Columbia and the interstate shipment of any worthless, contaminated, or harmful viruses, serums, toxins, or similar products intended for use in the treatment of domestic animals, and the interstate shipment of such viruses, serums, toxins, or similar products, unless prepared at an establishment licensed by the Secretary of Agriculture; prohibits importation of such products without permit from the Secretary of Agriculture; and authorizes the inspection of such products when offered for import and the destruction of such as are found to be worthless, contaminated, or harmful.

Copy of the act and the regulations thereunder will be found in B. A. I. Order 276.

Plant Quarantine Act.—Aug. 20, 1912 (37 Stat. 315), amended Mar. 4, 1913; Mar. 4, 1917; May 31, 1920.

This act is designed to prevent the entry into this country, through importation, or the further spread throughout the country, through interstate commerce, of dangerous plant disease and insect infestation. It authorizes the Secretary of Agriculture to prohibit or regulate the entry of nursery stock, plants, fruits, and plant products when found to be necessary to prevent the introduction of any new or not widely prevalent plant or fruit disease or injurious insect infestation and to quarantine any portion of the United States, when necessary to prevent the further spread of a dangerous plant disease or insect infestation, and prohibits the interstate movement from such quarantined areas of nursery stock, plants, fruits, or plant products or any article capable of carrying such disease or infestation, except under regulations issued by the Secretary of Agriculture.

Complete information on the introduction of plants and plant products may be obtained by application to the Federal Horticultural Board.

Seed Importation Act.—Aug. 24, 1912 (37 Stat. 506), amended Aug. 11, 1916 (39 Stat. 453); Apr. 26, 1926 (Public No. 151—69th Cong.).

This act is designed to protect farmers, and other users of seeds, by preventing the importation of all kinds of grass, clover, and grain seeds which are adulterated or unfit for seeding purposes. It defines the terms "adulterated" and "unfit for seeding purposes," when applied to seeds, and prohibits the importation thereof, with the proviso that such seeds may be delivered to consignee under bond, to be recleaned according to regulations prescribed by the department. By amendment of April 26, 1926, importation of alfalfa or red clover seeds or any mixture of seed containing 10 per cent or more of such seeds is prohibited unless they are colored as the Secretary of Agriculture may prescribe to indicate the country or region of origin; interstate traffic in misbranded seeds is prohibited and such seeds may be seized and confiscated by judicial proceedings. The act is largely self-enforcing, as the seed dealers in the United States are more generally making their purchases of seed in foreign countries subject to the requirements of the act.

Regulations under the seed importation act have been published as T. D. 36746, 38600, and 38868.

National Forest Laws.—Mar. 3, 1891 (26 Stat. 1103); June 4, 1897 (30 Stat. 34); Feb. 1, 1905 (33 Stat. 628), etc.

These acts are designed to authorize the creation, administration, and use of national forests in the public-land States, with a view to improve and protect the forests therein; to insure favorable conditions of water flows therein; and to furnish therefrom a continuous

supply of timber for the use and necessities of United States citizens. They provide for the administration of the lands so reserved by the Secretary of Agriculture under rules and regulations promulgated by him.

Weeks Forestry Law.—Mar. 1, 1911 (36 Stat. 961).

This act is designed to regulate the flow of navigable streams and to protect the forested watersheds of such streams against fire. It provides for the examination and purchase of such lands by the Government and for permanent reservations as national-forest lands. It also authorizes the sale of such small areas therein as may be occupied for agricultural purposes without injury to the forests or to stream flow. The act of August 11, 1916 (39 Stat. 476), authorizes the making of rules and regulations for the protection of game animals, birds, and fish on the lands so acquired.

Clark-McNary Act.—June 7, 1924 (43 Stat. 653).

Authorizes cooperation with States and other local agencies in forest-fire protection, a study of forest-tax laws, the distribution of forest-tree seeds and plants, and assistance to farm owners in establishing wood lots.

Agricultural Homestead Law.—June 11, 1906 (34 Stat. 233).

This act authorized the Secretary of Agriculture to examine, list, and procure the opening to entry under the homestead laws, of tracts of land within the national forests, not exceeding 160 acres in area, found to be chiefly valuable for agriculture and not needed for public purposes.

Federal-Aid Road Acts.—July 11, 1916 (39 Stat. 355); Feb. 28, 1919 (40 Stat. 1200); Mar. 15, 1920 (41 Stat. 530); Mar. 3, 1921 (41 Stat. 1349); Nov. 9, 1921 (42 Stat. 212); June 19, 1922 (42 Stat. 660); Jan. 22, 1923 (42 Stat. 1157); Feb. 26, 1923 (42 Stat. 1321); Mar. 10, 1924 (Public No. 35—68th Cong.); Apr. 9, 1924 (Public No. 70—68th Cong.); and June 5, 1924 (Public No. 201—68th Cong.).

These acts are designed to aid the States in the construction of roads. The first two mentioned laws provided for the construction of rural post roads; but the act of November 9, 1921, with its amendatory and supplementary acts, provides for a definite Federal-aid highway system consisting of primary or interstate and secondary or intercounty highways so correlated as to provide a national connected system.

Within certain limitations of mileage allowance, the Federal Government may pay not more than 50 per cent of the cost of a project, except in the public-land States where the Federal pro rata may be increased in proportion to the public-land area.

Under these acts roads and trails are constructed within or adjoining the national forests, with or without the cooperation of the States or local subdivisions.

Research and investigational studies in major highway and highway-transport problems are made to develop governing principles of the science of highway construction and highway transportation.

The acts provide for distribution to the State highway departments of surplus war supplies and equipment for use in highway improvement.

For expenditure under these acts, Congress has appropriated or authorized to be appropriated for forest roads $47,000,000 and for State Federal-aid roads $540,000,000, the latter sum being required to be apportioned among the States on the basis of area, population, and mileage of rural delivery and star mail routes.

Bulletins: Office of the Secretary Circulars 65 and 161; Senate Document 286—67th Congress, 4th session.

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Cotton Futures Act.—Aug. 11, 1916 (39 Stat. 476).

This act is designed to preserve to the cotton industry the advantages of the cotton futures exchanges, while eliminating, as far as possible, opportunity for artificial manipulation of prices by unfair and uneconomic practices. These exchanges provide a clearing house for the risk involved in price movements, making price insurance possible, whereby cotton merchants can remain in the market at all times and handle large quantities of cotton on narrow margins of profit. This system of merchandising benefits the producer by reducing the possibility of unnatural fluctuations of prices on the future exchanges, thus preventing artificial depressions of prices paid to such producers. The act authorizes the Secretary of Agriculture to establish standards for cotton by which its quality or value may be determined.

The following information concerns the operation of the act:

Service and Regulatory Announcements—

Markets No. 1. Establishment and Promulgation of Official Cotton Standards of the United States.

Markets No. 2. Determination of Disputes on Questions other than Grade Arising in Connection with the Fifth Subdivision of Section 5 of the United States Cotton Futures Act.

Markets No. 3. Publication of Rules and Regulations.

Markets No. 4. Distribution of Service and Regulatory Announcements.

Markets No. 5. The United States Cotton Futures Act.

Markets No. 6. The Official Cotton Standards of the United States.

Markets No. 7. Brief History of the Movement to Secure Universal Cotton Standards.

Markets No. 8. Necessity for Adequately Designating by Letters, Marks, or Lot Numbers the Bales Involved in Disputes.

Markets No. 9. Review of Some of the Provisions of the Pending Cotton Futures Bill, H. R. 11861, and of Causes of Differences between Prices of Middling Cotton in New York and Liverpool.

Markets No. 10. Changes Made in the United States Cotton Futures Act by its Reenactment on August 11, 1916.

Markets No. 16. Changes in Forms Heretofore Suggested for Papers Filed in Disputes under the United States Cotton Futures Act.

Markets No. 41. Public Notice Establishing Official Cotton Standards of the United States for American Egyptian Cotton.

Agricultural Economics No. 72. Establishment and Replacement of the Official Cotton Standards of the United States.

Circular 159. Regulations of the Secretary of Agriculture under the United States Cotton Futures Act.

The act is printed as an appendix.

Cotton Standards Act.—Mar. 4, 1923 (42 Stat. 1517).

This act is designed to establish a uniform system of classification for American cotton throughout the United States, thus making quotations of various markets comparable and making it possible for producers to determine the true value of their cotton by uniform classification. The act provides that holders of that cotton may submit it, or samples of it, to the Department of Agriculture under regulations prescribed by the Secretary of Agriculture and have the true classification of the cotton determined in accordance with standards established by the Department of Agriculture. It is made unlawful, in interstate or foreign commerce, to indicate for cotton of any grade within the standards established by the Secretary of Agriculture any name or description not within such standards.

The following information concerns the operation of the act:

Service and Regulatory Announcements—Agricultural Economics No. 80. Regulations of the Secretary of Agriculture under the United States Cotton Standards Act.

Service and Regulatory Announcements—Agricultural Economics No. 82. The United States Cotton Standards Act and the Universal Standards.

The act is printed as an appendix.

Food Products Inspection Law.—June 5, 1924 (Public, No. 201—68th Cong.).

This act authorizes the Secretary of Agriculture at shipping points, important central markets designated by the Secretary, and other points conveniently reached therefrom, to investigate and certify to shippers and other interested parties the class, quality, or condition of cotton, fruits, vegetables, poultry, butter, hay, and other perishable farm products moving in interstate commerce.

Service and Regulatory Announcements.—Rules and Regulations of the Secretary of Agriculture Governing the Inspection and Certification of Fruits, Vegetables, and Other Products.

Grain Futures Act.—Sept. 21, 1922 (42 Stat. 998).

This act is designed to prevent and remove obstructions and burdens upon interstate commerce in grain by regulating transactions on grain futures exchanges. It prohibits sales of grain futures except those made by the owner or grower of the grain or by or through a member of a board of trade designated by the Secretary of Agriculture as a "contract market," such designation to be given only upon compliance with all the conditions therefor as specified in the act.

A copy of this act and the rules and regulations promulgated thereunder are contained in Miscellaneous Circular 10.

Grain Standards Act.—Aug. 11, 1916 (39 Stat. 482).

This act is designed to facilitate domestic and foreign commerce in cereal grains. It authorizes the Secretary of Agriculture to establish standards of quality and condition for grains; to license inspectors to apply such standards; to handle appeals from inspectors' determinations on complaint of an interested party; and to determine the true grade of the grain, concerning which the appeal was made. In addition, there are regulatory provisions designed to prevent fraud and misrepresentation in the handling and shipping of grain.

Office of the Secretary Circular 70.—U. S. G. S. A. Form No. 90. Handbook of Official Grain Standards for Wheat, Shelled Corn, and Oats.

U. S. G. S. A. Form 133. Handbook of Official Grain Standards for Rye.

Standard Container Act.—Aug. 31, 1921 (39 Stat. 673).

This act is designed to protect producers of and dealers in fruits and vegetables from unfair competition and the consumers thereof from short measures. It establishes standards of size and measurement of climax baskets for fruits and vegetables and of baskets for small fruits, berries, and vegetables and makes it unlawful to manufacture or sell for interstate shipment or ship in interstate commerce, climax baskets or other containers for fruits, berries, or vegetables which do not conform to standard.

See Standard Barrel and Basket Laws, and Circular 76, Standard Container Act.

Warehouse Act.—Aug. 11, 1916 (39 Stat. 46).

This act is designed (1) to encourage proper storage of agricultural products; (2) to eliminate loose, unsound, or evil practices in warehousing; and (3) to develop a form of warehouse receipt covering agricultural products which will be acceptable generally to bankers as col-

lateral for loans. It accomplishes its purpose through a system of licensing warehousemen conducting a public storage business and also by licensing inspectors, weighers, graders, and samplers of products stored in licensed warehouses. The law is not mandatory. Only those who can meet the department's requirements may be licensed.

Circular No. 141. Regulations for Grain Warehouses.

Circular No. 150. Regulations for Wool Warehouses.

Circular No. 154. Regulations for Tobacco Warehouses.

S. R. A. No. 76. Revised Regulations for Cotton Warehouses.

S. R. A. No. 81. Regulations for Peanut Warehouses.

S. R. A. No. 83. Regulations for Potato Warehouses.

S. R. A. No. 84. Regulations for Broomcorn Warehouses.

Primer: Warehousing Farm Products under the United States Warehouse Act.

Banker: The Banker and the United States Warehouse Act.

Benefits Provided by the Compensation Act.—Sept. 7, 1916.

Persons protected by the compensation act:
- All civil employees of the United States and of the Panama Railroad Co.

Injuries for which compensation is payable:
- Personal injuries sustained on or after September 7, 1916, while in the performance of duty, and causing disability for work (with loss of pay) for more than three days.
- But not when caused by—
  - Willful misconduct of injured employee.
  - Injured employee's intention to bring about injury or death to himself or another.
  - Intoxication of injured employee (as proximate cause).

Medical services furnished in case of injuries:
- For all injuries sustained on or after September 7, 1916, while in the performance of duty, whether resulting in disability or not.
  - Reasonable medical, surgical, and hospital services and supplies, unless refused, and transportation to place of procuring them if necessary.
  - Services and supplies must be furnished by United States medical officers and hospitals if practicable; if such services are not available, then by private physicians and hospitals designated by the United States Employees' Compensation Commission, a list of which will be found in the hands of the official superior or head of the establishment. Where there is no designated physician or hospital, or United States medical officer or hospital, any reputable physician licensed to practice medicine, or any hospital, may be employed.

Money benefits payable in case of disability:
- If disability is total, 66⅔ per cent of the monthly pay (including value of subsistence and quarters, if furnished) during continuance of such disability, beginning on the fourth day of disability, or on the fourth day after pay stops if leave with pay is taken, but not more than $166.67 nor less than $58.33, unless the monthly pay is less than $58.33, in which case the monthly compensation shall be the full amount of the monthly pay.
- If disability is partial, 66⅔ per cent of the loss in wage-earning capacity due to the disability, subject to the same limitation as in the case of total disability.

Burial expenses payable in case of death:

- Burial expenses not exceeding $200, and transportation of body of resident of United States dying away from home station, if relatives desire it.

Money benefits payable in case of death:

- To dependents named below, monthly compensation equal to the specified percentage of deceased employee's monthly pay, which for computing this compensation shall be considered to be not more than $175 nor less than $87.50, but the monthly compensation can not exceed the monthly pay.
  - To widow or wholly dependent widower, 35 per cent of pay of deceased employee until death or remarriage.
    - And, in addition, for each child under 18, 10 per cent of monthly pay until death, marriage, or reaching the age of 18.
  - To one child under 18, if there is no widow or dependent widower, 25 per cent of monthly pay.
  - To each additional child under 18, 10 per cent.
    - To be divided among the children equally.
    - To be paid, until death, marriage, or reaching age of 18, to child's guardian.
  - If there is no widow, or dependent widower, or child under 18:
    - To one parent, if wholly dependent, 25 per cent.
    - To two parents, if wholly dependent, each 20 per cent.
    - To parent or parents, if partly dependent, proportionate amounts, to be determined by the commission.
      - To be paid for eight years, or until death, marriage, or ending of dependency.
  - If there is a widow, or dependent widower, or child under 18, dependent parents will be paid so much of above percentages as added to payments to widow or widower and children will not exceed 66⅔ per cent of monthly pay.
  - If there is no widow, widower, child, or dependent parent:

Brothers Sisters Grandparents Grandchildren	If wholly dependent on deceased.	To one person, 20 per cent of monthly pay. To more than one person, 30 per cent, share and share alike.
	If partly dependent on deceased.	To one or more persons, 10 per cent, share and share alike.

- To be paid for eight years, or until death, marriage, or reaching age of 18.
- If there is a widow, widower, child, or dependent parent, dependent brothers, sisters, grandparents, or grandchildren, shall be paid so much of above percentages as added to payments to widow, child, and dependent parents, will not exceed 66⅔ per cent of monthly pay.

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Employee's right to make claim for compensation:

The employee is entitled to have any claim for payment of compensation or medical or hospital service on account of an injury which he believes was sustained while in the performance of duty on or after September 7, 1916, passed upon by the Employees' Compensation Commission.

Cooperative extension employees who receive a salary from funds appropriated to the Department of Agriculture or appointed as collaborators of that department "without compensation" are entitled to all necessary medical and hospital care for the results of injuries sustained while in the performance of duty, in accordance with the provisions of section 9 of the compensation law. They are also entitled to money compensation, based upon the rate of pay received at the time of injury from Federal funds, that is, including funds paid directly by the Department of Agriculture and amounts paid from *Federal Smith-Lever funds.*

Extension employees receiving a portion or all of their salary from *Federal Smith-Lever funds,* but holding *no appointment as a Federal agent* in the United States Department of Agriculture or other Federal department, would *not* be entitled to the benefits of the Federal compensation act.

No Employee to Receive Other Than Government Salary for Services.— Act of March 3, 1917 (39 Stat. 1106).

Provided, That on and after July first, nineteen hundred and nineteen, no Government official or employee shall receive any salary in connection with his services as such an official or employee from any source other than the Government of the United States, except as may be contributed out of the Treasury of any State, county, or municipality, and no person, association, or corporation shall make any contribution to, or in any way supplement the salary of, any Government official or employee for the services performed by him for the Government of the United States. Any person violating any of the terms of this proviso shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be punished by a fine of not less than $1,000 or imprisonment for not less than six months, or by both such fine and imprisonment as the court may determine.

Cooperation; Contribution from Outside Parties.—Act of July 2, 1919 (41 Stat. 234, 270).

That hereafter in carrying on the activities of the Department of Agriculture involving cooperation with State, county, and municipal agencies, associations of farmers, individual farmers, universities, colleges, boards of trade, chambers of commerce, or other local associations of business men, business organizations, and individuals within the State, Territory, District, or insular possession in which such activities are to be carried on, moneys contributed from such outside sources, except in the case of the authorized activities of the Forest Service, shall be paid only through the Secretary of Agriculture or through State, county, or municipal agencies, or local farm bureaus or like organizations, cooperating for the purpose with the Secretary of Agriculture.

Publications

Requests should be sent to the Office of Cooperative Extension Work and not to the Office of Information.—By arrangement in the department all requests for publications for the use of extension workers are approved in this office before being filled by the Office of Information. Therefore, such requests should be sent directly to this office if for a few copies, or through the office of the State extension director if for publications in quantity. Do not address requests to the Office of Information or any other bureau of the department.

Requests for more than 25 copies of any bulletin should bear the approval of the State extension director.—Requests for farmers' bulletins in quantities, or for other publications issued for general distribution, will not be approved in this office unless they bear the approval of the extension director or some one acting for him and there is shown to be special need for the larger quantities.

Series should be designated.—In requests for bulletins it is imperative that the series be designated; i. e., farmers' bulletin, department bulletin, department circular, miscellaneous circular, statistical bulletin, or yearbook separate. For example, if Bulletin 107 is ordered, it is impossible to know whether Farmers' Bulletin 107, Technical Bulletin 107, Circular 107, or Bulletin 107 in some other series is desired. The same precaution should be taken with other publications.

Numerical order should be followed in lists of serial numbers of publications requested.—All serial numbers of publications requested should be listed in numerical order. This will facilitate filling requests, as all supplies of publications in stock are regularly arranged in numerical order.

Publications may be sent in quantities to agent for remailing.—Extension workers are encouraged to order publications in bulk for remailing rather than to send in long lists of the names of individuals to whom bulletins are to be sent. When bulletins are remailed the most efficient use is obtained when the agent incloses a letter with the publication, stating why it is considered of special importance to the individual to whom it is sent. In view of the great demand for bulletins, care should be taken not to order more copies than are actually required.

Promiscuous distribution of bulletins is discouraged.—The distribution of bulletins to general mailing lists or at fairs, picnics, institutes, and other gatherings is discouraged. The practice is wasteful and tends to cheapen the service. The individual who has a miscellaneous collection of bulletins thrust upon him, many of which are of no interest to him, is not apt to read them.

The following are the chief regular series of publications and periodicals of the department of interest to extension workers:

(1) **Farmers' Bulletins.**—As long as the department's somewhat limited supply of farmers' bulletins lasts copies may be obtained by all applicants free of charge. Under existing law one-fifth of the farmers' bulletins printed is distributed by the United States Department of Agriculture, the remaining four-fifths being placed at the disposal of Members of Congress, each of whom has a lim-

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ited quota. Because of this limitation not more than 10 copies are ordinarily sent to any private individual.

(2) Technical Bulletins.—This series includes technical or scientific treatises applying to a special industry or locality. The editions are limited, but as long as the supply lasts they usually can be furnished in small quantities to agents who have need for such specialized information. Requests in quantities should state the use intended to be made of them.

(3) Circulars.—These contain such short papers as it may from time to time seem advisable to issue, which, because of their brevity or for other reasons may be unsuitable for the department bulletin and farmers' bulletin series. They are issued in very limited editions and are available in small numbers for free distribution by extension workers upon the approval of the bureau in which they originate.

(4) Miscellaneous Publications.—These include those publications of the department which do not fall within any of the series outlined above or which are other than regular octavo size. Editions vary greatly.

(5) Statistical Bulletins.—These contain statistics relating to one or more closely related agricultural commodities. Editions vary greatly, but generally are small.

(6) Soil-Survey Reports.—Editions of reports of soil surveys are limited, and distribution is controlled by the Bureau of Soils. If an agent's county has been mapped, a copy of the report can usually be obtained for his use, the use of the committee on soils of the local extension organization, etc. Senators and Members of Congress representing the State and district where the survey was made have an allotment of these reports.

(7) Lists of New Publications.—The department issues from time to time announcements of its new publications. These are sent out on post cards, and are not released at regular intervals, but only as occasion warrants. The department encourages the adding of names of individuals to receive these announcements of new publications. As separate announcements are issued for popular bulletins and for technical bulletins, it should be indicated whether the individual is interested in scientific and technical publications prepared primarily for research workers or interested only in popular bulletins prepared for general distribution. The same information is issued weekly in the Official Record which is sent to all extension workers. For this reason the names of extension workers are not placed on the mailing list to receive these announcements of newly issued publications.

(8) List of Farmers' Bulletins Available for Free Distribution.—Lists of farmers' bulletins available for free distribution are issued from time to time by the Office of Information. One list has the bulletins arranged in numerical order and another list shows the same publications arranged by subject matter. A third list gives a selection of farmers' bulletins of interest in cities and towns, these bulletins being devoted to household, garden, poultry, and such subjects. Copies are sent to extension workers, and, if desired, a limited supply may be had for giving out by the agents to persons interested in farmers' bulletins. It should be kept in mind, however, that requests for publications *should not be sent in on the list of publications arranged according to subject matter.* For this purpose the numerical list should be used.

(9) List of State Extension-Service Publications.—Titles of State extension-service publications received during the month by the Office of Experiment Stations library are listed in this mimeographed monthly pamphlet. The department does not distribute any of the publications listed. They may be obtained only from the State exten-

sion service publishing them. The names and addresses of all extension agents upon appointment are automatically placed upon the mailing list to receive this monthly list of State extension-service publications.

(10) **Official Record.**—A weekly printed publication which contains official announcements and information concerning the work of the department. Each issue has a list of the titles and serial numbers of all publications issued by the department during the previous week. The names of all extension agents as soon as appointed are automatically placed on the mailing list to receive this publication regularly.

(11) **Experiment Station Record.**—This monthly technical review of the world's scientific literature pertaining to agriculture is not intended for general distribution. The offices of extension agents will be placed on its mailing list only on special application and when approved by the extension director and this office.

(12) **Crops and Markets.**—A monthly printed publication covering all crop and livestock statistics issued during the month. Copies are automatically sent to all extension directors, State county-agent leaders, county agents, farm-management demonstrators, leading crop reporters, and to all others for a subscription price of 60 cents per year.

(13) **The Agricultural Situation.**—This is a brief printed monthly summary of economic conditions, and is automatically sent to extension directors, State county-agent leaders, county agents, and farm-management demonstrators. To others the subscription price is 25 cents per year.

(14) **Agricultural Cooperation.**—A mimeographed news sheet issued biweekly as a clearing house for exchange of news and ideas in the field of agricultural cooperation. The names of extension workers will be placed on the mailing list only if they make special request through their extension directors.

(15) **Foreign Crops and Markets.**—A weekly mimeographed news sheet reporting crop and market developments in foreign countries. Names are placed on its mailing list only on special request.

(16) **State and Federal Marketing Activities.**—A weekly mimeographed publication designed to serve as a clearing house for news of developments in the field of economic and marketing activities. It is sent only on special request.

Publications of Other Bureaus and Departments.—The Office of Cooperative Extension Work is glad to assist extension workers to obtain publications of other bureaus of the United States Department of Agriculture or of other departments that are needed by them in carrying on their work. Requests for such publications should give the *name of the publication, the serial number* if it has one, and the *department publishing it*, to assist the office in identifying the exact publication desired.

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.83 Accomplishments.
.830 General.
.831 County agent work.
.832 Home demonstration work.
.833 Boys' and girls' club work.
.834 Specialists' work.
.835 Negro work.
.839 Miscellaneous.
.89 Miscellaneous.
.9 Miscellaneous.
.91 Services available.
.910 General.
.911 Federal.
.9111 Office of Cooperative Extension Work.
.9112 Office of Exhibits.
.9113 Office of Motion Pictures.
.9119 Miscellaneous.
.912 State.
.919 Miscellaneous.
.99 Bibliography.
.991 Books.
.992 Bulletins, circulars.
.993 Periodicals.

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EXTENSION

GENERAL

Terminology

The following extension terms have been defined for the use of county extension agents in their annual reports:

(1) A Program of Work is a definitely outlined plan of extension work.

(2) A Project is a definite, systematic, organized plan for carrying out some phase of the extension program of work, providing for what is to be done, how much, when, where, how, and by whom.

(3) Miscellaneous Work includes work which has not yet become a regular part of the program of work—work other than project work.

(4) A Community may be any one of the several units into which the county is divided for the purpose of conducting organized extension work.

(5) A Project Leader or Local Leader is a person, selected because of his or her special interest and fitness, who functions as a leader in advancing some phase of the local program of extension work.

(6) A Demonstration is an example designed to show the practical application of an established fact. Demonstrations are of two kinds, method demonstrations and result demonstrations.

A method demonstration is a demonstration given by an extension worker or other trained leader to a group for the purpose of showing them how to carry out a practice. Synonym: Lecture demonstration. Examples: Demonstrations of canning, mixing of spray materials, and culling of poultry.

A result demonstration is a demonstration carried on by a farmer, farm woman, boy, or girl under the direction of the extension service, involving a substantial period of time, records of results, and comparisons. Examples: Child-feeding, corn-culture, and orchard-management demonstrations.

(7) A Demonstrator is a farmer, farm woman, boy, or girl who, under the direction of the extension service, conducts a result demonstration.

(8) Members Completing should include those who have satisfactorily finished the work outlined for the current year.

(9) A Demonstration Meeting is a meeting held to give a method demonstration or to start, inspect, or further a result demonstration.

(10) A Training Meeting is a meeting at which project leaders or local leaders are trained to carry on extension activities in their respective communities.

(11) An Office Call or Telephone Call is a visit or call by a farmer or other person seeking agricultural or home-economics information, as a result of which some definite assistance or information is given.

(12) A Farm Visit is a call at a farm by the agent at which some definite information is given or concrete plan of work is outlined, or some valuable information obtained from the farmer regarding his work, or the better practice prevailing in his neighborhood.

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(13) A Home Visit is a call at a home by the agent at which some definite information is given or concrete plan of work outlined, or some valuable information obtained from the farm woman regarding her work, or the better practice prevailing in her neighborhood.

(14) Days in Office should include time spent by the county agent in his office, at county agent conferences, and any other work directly related to office administration.

(15) Days in Field should include all days spent on official duty other than those spent in office.

(16) Letters Written should include all single letters on official business.

(17) A Farmers' Institute is one of a series of meetings of one to two days' duration, arranged by a central State farmers' institute agency, at which agricultural and home-economics problems are discussed, usually by outside speakers employed for the purpose.

(18) An Extension or Movable School is an itinerant school usually of two to six days' duration where practical and systematic instruction is given to persons not resident at the college. An Extension Short Course differs from an extension school in that it is usually held at the college or other educational institution and usually for a longer period of time, but not exceeding two weeks.

(19) Records consist of definite information filed in the county office that will enable the agent to verify the data on extension work included in his reports.

(20) Farm or Home Practice Adopted is a new or improved practice adopted on a farm or in a home during the year as a result of extension teaching. Examples: Spraying of potatoes for disease, canning of fruits and vegetables, use of balanced rations, and hat making.

HISTORY AND DEVELOPMENT

Foreign Countries

Africa.—In 1922 a definite Government system of extension work was inaugurated by the division of extension of the Department of Agriculture in the Union of South Africa. The organization of the work includes the appointment of district agents or circle instructors corresponding to the county agents in the United States. They must be agricultural college graduates and keep in close touch with the college as well as the farmers. Demonstration trains and extensive lecture tours are used during the winter months.

Argentina.—Agricultural extension work was begun in 1907. A territory large enough for one man to attend to properly is in charge of a regional agronomist corresponding to the county agent in the United States. All agronomists must be graduates of a university or specialized school. The extension work is administered entirely by the Federal Government, the provincial governments making no contribution to the work of agricultural education. The duties of the agronomists consist largely in making personal contact with farmers and giving lectures at meetings and organized demonstrations. There are no movable schools for males, but Argentine farm home schools for girls are held throughout the rural districts, lasting three months and dealing with the various home-economics subjects as well as vegetable gardening and poultry.

Belgium.—The Ministry of Agriculture directs the agricultural extension work through 30 agronomists. They correspond to the county agents in the United States, and each is responsible for the direction of all extension work in his sphere of activity. Their duties are to organize and direct all kinds of courses in agriculture and related subjects for men, women, boys, and girls, establish experimental and demonstration fields, direct the formation of cooperative and other agricultural societies, and give advice orally and by correspondence to all classes of rural people, with whom they are to keep in constant touch. There are also farm housekeeping advisers, horticultural advisers, veterinary inspectors, and forest agents. All these specialists are appointed and paid by the Government. Though most of the funds are provided by the Ministry of Agriculture, the provincial and communal administrations, as well as the agricultural societies contribute. Belgium is noted for its splendid work with farm women, which began in 1887.

Canada.—Each provincial department of agriculture maintains, in almost every agricultural county and district, an agricultural representative, who sometimes has assistants. This representative gives special short courses and lectures for farmers during winter, conducts demonstrations, makes personal visits during the summer, and advises orally and by correspondence. The cost of the work is borne by the department and the Provinces jointly. Extension work with farm women has become renowned and is known as women's institutes. Their activities include granting scholarships in agricultural colleges for boys and girls, boys' and girls' club work, child-welfare clubs, school and rural commu-

nity betterment, as well as home-economics instruction. These institutes are directed by a superintendent—an officer of the provincial department of agriculture, under whom is a corps of full-time women lecturers or demonstrators, who hold short courses, give lectures, and conduct demonstrations in home economics and allied subjects. The work is financed by the Government under the Dominion instruction act.

Czechoslovakia.—In 1922 the Government established in each Province an agricultural chamber for the promotion of agriculture and in each county an agricultural association in which membership is compulsory. The most important extension work in agriculture is being done in the Province of Bohemia, where 20 illustration or demonstration farms are owned and operated by individuals under supervision of the agricultural board. The Agricultural Board of Bohemia employs a number of part-time specialists who visit farms, give lectures, and conduct experiments, demonstration fields, and machine trials.

Denmark.—About 20 full-time State-appointed agricultural advisers who are expert specialists, and more than 200 mostly full-time but some part-time local county-appointed advisers visit the farms in their respective territories during the summer and give personal, technical advice and conduct demonstrations. In the winter they hold six-day courses on various agricultural subjects, including home economics and bookkeeping, throughout the rural districts. The management of this work is in charge of the Royal Agricultural Society, small holders' societies, the Danish Heath Society, the local agricultural societies, and the Government in so far as approval of their plans is concerned. These societies are entitled to receive reimbursement from the Government for half the compensation paid the local advisers, most of whom are graduates of the Royal Agricultural College.

England and Wales.—Nearly every county maintains an agricultural council, the head of which is the agricultural organizer, who is in direct charge of extension activities and whose entire time is given to the work of directing the itinerant staff and establishing demonstration and experimental plots. There are 46 agricultural organizers, assisted by a large staff of full and also part time workers, whose activities include demonstrations, day and evening courses for men, women, boys, and girls, the range of subjects being very comprehensive, and advisory work through personal visits and correspondence. There are also held a large number of traveling schools on various subjects, especially cheese making. There are 12 universities, each provided with an agricultural department or college, the staffs of which are specialists who travel among the farmers and give assistance when requested by the organizers. In addition a large number of technical specialists are employed by the ministry and serve the entire country through correspondence. Boys' and girls' clubs were established for the first time in 1921, and their popularity and growth have been surprising. They are modeled after those in the United States.

France.—The Ministry of Agriculture has for extension purposes divided France into eight regions, each in charge of an inspector general, with directors of agriculture assisting, and many extension workers in various sections. Their duties are largely confined to holding short courses or movable schools and directing the assistants, called professors of agriculture, who are the field workers with the farmers and function as our county agents, with similar duties except that they also conduct purely experimental fields. The inspector general's office

also maintains a corps of specialists to give advice on specific problems.

Germany.—Extension work is fostered by the central agricultural society and provincial agricultural chambers through school districts as units, each one with a winter agricultural school. The director and teachers (specialists) devote the remainder of the year to itinerant work among the farmers. Part and whole time specialists are also employed as itinerant workers. Itinerant housekeeping schools for farmers' daughters 16 to 20 years of age, are an important feature of the extension system.

India.—The task of improving an agricultural people of low mentality and energy and with a strong adherence to tradition has confronted all efforts to better agriculture in India. Energies have been concentrated on three lines of attack, namely better implements, proper manuring, and superior varieties of crops instead of the inferior ones grown for centuries. The advances made have been due to the scrupulous regard and consideration shown for the cultivators' own capital, capabilities, and conditions, the ocular demonstrations given on the cultivators' own fields, and the establishment by the Department of Agriculture of seed farms and depots for the sale of implements and improved varieties of plants and seeds. Vast numbers of agricultural societies have been established and are now greatly influential in furthering agricultural progress.

Ireland.—Extension work in agriculture was established more than 20 years ago, when the Department of Agriculture was created. Each of the 33 counties has a council, which appoints an agricultural committee. This committee in turn appoints itinerant instructors, approved by the department, in agriculture, poultry keeping, dairying, horticulture, and beekeeping. Their duties include the entire range of extension teaching methods, and their salaries and expenses are paid jointly by the department and the counties.

Italy.—Agricultural extension work in Italy had its inception in 1870 and is a joint effort between the State and the Province, each of which is bound by royal decree to contribute to its support. Each Province has one or more movable chairs of agriculture, of which there are more than 300. Each chair consists of a director and one or more assistants. All the chairs are engaged in itinerant agricultural work centered in the Ministry of Agriculture, but largely autonomous, each having its own vigilance committee to manage its affairs. The duties of the itinerant professors of agriculture cover the entire range of extension activities found in the United States, with emphasis on short courses and individual lectures, but not neglecting experimental and demonstration plots and personal visits. Work with rural women in Italy is almost entirely an activity of local societies with little State aid.

Netherlands.—Officials called farm advisers are appointed by the Government in each of the 11 Provinces, whose duties are to give lectures to farmers on agriculture and horticulture, visit their farms to give advice, supervise the various winter short courses for farmers, farm women, boys, and girls, conduct experiment and demonstration fields, attend agricultural associations, and on market days meet the farmers in order to give advice. Specialists are also appointed by the Government in dairying, livestock raising, beekeeping, and poultry raising.

Norway.—Extension work conducted along lines similar to that given for Sweden.

Spain.—An agronomic engineer is assigned to each of the 49 Provinces. He has charge of the technical, experi-

mental, propaganda, and instructional work in agriculture, collects statistics, and reports on general agricultural conditions. Working under each of the agronomic engineers are one or more men whose positions are called itinerant chairs. Their duties consist in studying the needs of agriculture, suggesting means for its improvement, disseminating agricultural information, both written and oral, giving lectures, conducting field demonstrations, and assisting the cooperative associations.

Sweden.—Expert agriculturists known as agricultural advisers paid by contributions from the Government as well as from the various agricultural societies, travel over the country giving the farmers advice, conduct demonstrations, gather statistics, and give courses in general agriculture, bookkeeping, and home economics.

Switzerland.—A State law providing for extension work in agriculture was adopted in 1920. It established winter schools in the principal agricultural regions and summer housekeeping schools for young country girls, the faculties acting also as itinerant instructors. The department conducts short courses or schools on various subjects throughout the rural districts, also numerous individual lectures by specialists on all agricultural and home-economics subjects. The above are all paid for by the Government. In addition, the Swiss Agricultural Society and the various agricultural organizations in the Cantons provide instruction by means of lectures from specialists and recognized practical men. Farm bookkeeping is emphasized. Demonstrations are not featured.

United States

Early Extension Work.—From their beginning the agricultural colleges and the Department of Agriculture disseminated agricultural information among the farming people through correspondence, distribution of publications, and addresses at meetings by members of their staffs. This work was greatly increased through their connection with the farmers' institutes. The colleges gradually enlarged the scope of their extension work, particularly in the decade beginning about 1905, when distinct extension divisions were organized. Among the activities added were reading and correspondence courses, extension schools, competitive judging of livestock and other products, and boys' and girls' clubs.

The spread of the cotton-boll weevil in Texas led the Department of Agriculture, through the Bureau of Plant Industry, to attempt not only to diminish the injury to the cotton crop by this insect but also to offset its attack by improving the general practice of agriculture in the South. Through this movement was developed, under the leadership of Seaman A. Knapp, beginning in 1903, the system of extension work through supervised demonstrations by farmers on their own farms, county agricultural and home demonstration agents, and boys' and girls' clubs. At first this work was independent of the colleges, but gradually they came into more or less definite cooperation with it. The States and counties in the South also made appropriations for its support. By 1914 more than 1,000 men and women agents were employed in 15 Southern States.

In 1909 the office of farm management of the Bureau of Plant Industry began farm demonstration work in Ohio, and in 1911 the first county agent was appointed in New York. This work spread in the Northern and Western States in cooperation with the agricultural colleges, counties, and local organizations. In 1914 more than 200 agents were employed in this work.

Extension Legislation.—In 1905 a standing committee on extension work was appointed by the Association of American Agricultural Colleges and Experiment Stations. This committee reported in 1908 in favor of a Federal appropriation for extension work, and in 1909 a similar recommendation by the committee was adopted by the association. As a result a bill for this purpose was introduced in the House of Representatives, December 15, 1909, by James C. McLaughlin, of Michigan. The same general proposition was embodied in other bills in both houses. The Department of Agriculture joined in this movement. After long and careful consideration Congress passed the Smith-Lever Extension Act, which was approved by President Wilson, May 8, 1914.

Extension System.—This act was broadly drawn to make possible the establishment of a permanent nation-wide system of extension work in agriculture and home economics which would include both the demonstration and county-agent system and the other useful features of extension work as developed by the agricultural colleges. It provided for definite cooperation between the colleges and the Department of Agriculture in the planning, administration, and conduct of the work. Soon after the passage of the act the department and the colleges generally entered into a formal agreement, through a "memorandum of understanding," regarding the organization of cooperative extension work and their respective relations thereto.

Pending authorization by Congress of a permanent organization in the department to carry on the business necessitated by this act, a committee consisting of the director of the Office of Experiment Stations and the chiefs of the two offices in the Bureau of Plant Industry which were conducting demonstration work was appointed by Secretary Houston.

On July 1, 1915, this business was taken over by the newly created States Relations Service. General supervision was committed to the director of that service and the detailed work was intrusted to two offices of extension work transferred from the Bureau of Plant Industry. The office of extension work in the South was given charge of the work in 15 Southern States and the office of extension work in the North and West of the work in 33 Northern and Western States. In addition to work under the Smith-Lever Act, the States Relations Service administered the direct department appropriations for farmers' cooperative demonstration work. These funds have been used mainly in the States, but also for the maintenance of the Washington extension office.

Among the major problems which necessarily received much attention in the first years after the passage of the Smith-Lever Act were (1) the interpretation of this act as related to the legality of expenditures under it; (2) the establishment of a system for plans of work, budgets, accounting, and reporting; (3) the uniting of the force employed by the department in the South with the college extension forces; (4) the development on a larger scale of the county-agent system in the North and West and the building up of home demonstration and boys' and girls' club work in that region; and (5) the further development of organizations of farming people to support the extension work and participate in it.

The new plans and methods of work in the department and the States under the Smith-Lever Act and related Federal and State legislation were scarcely established when the entrance of the United States into the World War brought unusual difficulties and a very great expansion of effort.

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Under the food production act the States Relations Service received $4,348,400 in 1917 and $6,100,000 in 1918. This money was used to supplement the regular Federal, State, and county extension funds in stimulating agricultural production and food conservation. Much of the work under the latter head was done in cooperation with the Food Administration. In other lines of war work there was also much cooperation with the Red Cross, Council of National Defense, War Department, Public Health Service, Fuel Administration, Treasury Department (in Liberty loan campaigns), and other agencies.

The organization of the counties for extension work was pushed forward very rapidly, until more than 2,400 counties had agricultural agents and about 1,700 counties and 200 cities had home demonstration agents. About 2,000,000 boys and girls were enrolled in clubs. The agents and clerks with headquarters at the colleges and the department were also greatly increased in number. At one time about 7,000 persons were carried on the rolls of the States Relations Service.

To accomplish this task, it was necessary to organize the farming people more thoroughly. The extension forces were therefore very active in promoting the older organizations and forming new ones. In the Northern and Western States farm bureaus were organized in a large number of counties. This had unexpected results after the war, when economic conditions aroused the farmers to the importance of cooperative marketing and of legislation pertaining to agricultural affairs. The county farm bureaus expanded their work beyond the educational field and formed State and national federations. This movement has spread into almost all the States and has resulted in one of the strongest of our farm organizations. It has made necessary a readjustment of the relations of the extension forces to the farm bureaus in order that the extension work may remain an educational enterprise.

Office Organization.—With the nation-wide spread of the extension work and the approximate standardization of its purposes and methods, it became apparent that it would be much better to have the Federal business connected with this work transacted through a single office in the States Relations Service. Therefore, on October 1, 1921, the two offices were combined. Since that time much has been done toward adjusting the Washington office to new conditions in the department and the States. In order that the department as a whole might enter more fully into the extension work and the different bureaus might have more definite relations to the extension office and the State and county cooperative workers, general supervision of the extension work of the department was temporarily given to the Assistant Secretary of Agriculture and the way prepared for such supervision by a permanent director of extension work, provided for in the appropriation act for the fiscal year ended June 30, 1924. The States Relations Service was abolished on June 30, 1923, and the Extension Service was formed to take its place. The new service is composed of the following units: (1) Office of Director, (2) Office of Cooperative Extension Work, (3) Office of Exhibits, (4) Office of Motion Pictures, (5) Office of Demonstrations on Reclamation Projects, and (6) Office of Agricultural Instruction. Extension representatives of different bureaus were placed under the direction of the Office of Cooperative Extension Work as regards their plans of work and contacts with the field, while they hold office in the bureaus which are held responsible for the subject matter of their extension teaching.

On January 1, 1922, the Washington extension office was reorganized into three divisions: (1) Office administration, (2) programs, and (3) methods of extension organization and teaching. The division of programs carried on the work relating to the administration of the Smith-Lever Act and related Federal legislation, including plans of work, budgets, inspection of work and expenditures, and consultations with State extension officers regarding the administration of their work. The division of methods collected and disseminated information regarding methods of organization of different lines of extension work and methods of extension teaching of different subjects. A distinct effort has been made to consider the extension work as one unified enterprise for the benefit of the men, women, and children on American farms and to interest all extension agents in the promotion of the enterprise as a whole, rather than simply the particular line of work in which they individually are engaged.

On December 6, 1923, further readjustments were made in the Washington office as follows: (1) Office administration, and (2) field work. The latter was divided into (*a*) organization and administration, and (*b*) specialized service. Under (*a*) the United States was divided into four divisions—eastern, southern, central, and western—with an officer in charge of each, and under (*b*) were placed subject-matter specialists, extension studies, and visual instruction and editorial work.

During the 12 years since the passage of the Smith-Lever Extension Act a broad system of practical instruction for the men, women, and children on American farms, outside the schools, has been developed on a permanent basis by the cooperative efforts of the department and the State agricultural colleges, aided by the counties, farm organizations, and numerous individuals. The extension system is now organized to a greater or less extent in more than 2,100 agricultural counties and annually reaches directly several millions of our farming people. More and more it has formed a broad basis of popular support of research and education in agriculture and home economics through Federal, State, and local institutions, and undoubtedly the influence of the extension work will be increasingly felt in the development of these institutions.

The entire State field service on June 30, 1924, numbered 4,744 persons. Of this number, 3,427 were located permanently in the counties, 2,174 being in county agent work, 851 in home demonstration work, 133 in boys' and girls' club work, and 269 in extension work with negroes. The county workers were assisted in their work by 696 full-time and 174 part-time subject-matter specialists located at the State agricultural colleges. There were 394 persons employed as supervisors and assistant supervisors, while the administrative officers and their immediate assistants numbered 53. Of the above total, 3,751 were cooperative employees of the Office of Cooperative Extension Work, practically all engaged either in county work, supervision of county work, or farm-management demonstrations.

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PERSONNEL

Department Extension Service

C. W. Warburton	Director.
Leonore B. Fuller	Administrative Assistant.

OFFICE OF COOPERATIVE EXTENSION WORK

C. B. Smith	Chief.
J. A. Evans	Assistant chief.
T. Weed Harvey	Assistant to chief.
M. M. Thayer	Administrative assistant.
W. H. Conway	Financial records.

EXTENSION STUDIES

M. C. Wilson	In charge.
J. M. Stedman	Associate agriculturist.

VISUAL INTRUCTION AND EDITORIAL WORK

Reuben Brigham	In charge.
C. H. Hanson	Associate specialist, visual instruction.
L. A. Schlup	Assistant.

EASTERN STATES

Florence E. Ward	In charge.
H. W. Hochbaum	Agriculturist.
R. G. Foster	Agriculturist.

CENTRAL STATES

G. E. Farrell	In charge.
Grace E. Frysinger	Home economist.
H. W. Gilbertson	Agriculturist.
R. A. Turner	Agriculturist.

SOUTHERN STATES

O. B. Martin	In charge.
Ola Powell Malcolm	Home economist.
C. L. Chambers	Agriculturist.
I. W. Hill	Agriculturist.
T. M. Campbell	Field agent (negro work).
J. B. Pierce	Field agent (negro work).

WESTERN STATES

W. A. Lloyd	In charge.
Madge J. Reese	Home economist.
Eugene Merritt	Agriculturist.

SUBJECT-MATTER SPECIALISTS

A. B. Graham	In charge.
Miriam Birdseye	Extension nutritionist.
C. P. Close	Extension horticulturist.
G. H. Collingwood	Extension forester.
H. M. Dixon	Extension farm economist.
O. S. Fisher	Extension agronomist.
L. A. Jones	Extension agent, agricultural engineering.
C. D. Lowe	Extension animal husbandman.
F. P. Lund	Extension agent, food preservation.
F. C. Meier	Extension plant pathologist.
H. L. Shrader	Extension poultry husbandman.
Gertrude L. Warren	Extension agent, club organization.

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OFFICE OF MOTION PICTURES

Raymond Evans	Chief.
Edward J. Kelly	Film Editor.
George R. Georgens	Chief cinematographer.
Howard Greene	Technical animator.

OFFICE OF EXHIBITS

J. W. Hiscox	Chief.
H. T. Baldwin	Specialist in exhibits.
C. A. Lindstrom	Specialist in exhibits.
H. F. Marti	Specialist in exhibits engineering.
C. H. Cross	Junior administrative assistant.

OFFICE OF AGRICULTURAL INSTRUCTION

E. H. Shinn	In charge.
F. A. Merrill	Associate agriculturist.
C. H. Schopmeyer	Associate agriculturist.

OFFICE OF DEMONSTRATIONS ON RECLAMATION PROJECTS.

A. C. Cooley, Salt Lake City, Utah	In charge.

State Directors of Extension Service

Alabama	L. N. Duncan, Alabama Polytechnic Institute, Auburn.
Arizona	P. H. Ross, College of Agriculture, University of Arizona, Tucson.
Arkansas	Dan T. Gray, director, College of Agriculture, University of Arkansas, Fayetteville. T. R. Reid, assistant director, 310 Federal Bank and Trust Building, Little Rock.[1]
California	B. H. Crocheron, College of Agriculture, University of California, Berkeley.
Colorado	Roud McCann, State Agricultural College of Colorado, Fort Collins.
Connecticut	B. W. Ellis, Connecticut Agricultural College, Storrs.
Delaware	C. A. McCue, University of Delaware, Newark.
Florida	Wilmon Newell, Agricultural Extension Service, Experiment Station, Gainesville.
Georgia	J. Phil Campbell, Georgia State College of Agriculture, Athens.
Idaho	E. J. Iddings, College of Agriculture, University of Idaho, Moscow.
Illinois	H. W. Mumford, College of Agriculture, University of Illinois, Urbana.
Indiana	G. I. Christie, Purdue University, La Fayette.
Iowa	R. K. Bliss, Iowa State College of Agriculture and Mechanic Arts, Ames.
Kansas	H. J. C. Umberger, Kansas State Agricultural College, Manhattan.
Kentucky	T. P. Cooper, College of Agriculture, University of Kentucky, Lexington.

[1]All general correspondence is conducted by the assistant director.

Louisiana	W. R. Perkins, Louisiana State University and Agricultural and Mechanical College, University Station, Baton Rouge.
Maine	L. S. Merrill, College of Agriculture, University of Maine, Orono.
Maryland	T. B. Symons, University of Maryland, College Park.
Massachusetts	W. A. Munson, Massachusetts Agricultural College, Amherst.
Michigan	R. J. Baldwin, Michigan State College, East Lansing.
Minnesota	F. W. Peck, Department of Agriculture of the University of Minnesota, University Farm, St. Paul.
Mississippi	R. S. Wilson, Mississippi Agricultural and Mechanical College, A. & M. College.
Missouri	A. J. Meyer, College of Agriculture, University of Missouri, Columbia.
Montana	J. C. Taylor, Montana State College of Agriculture and Mechanic Arts, Bozeman.
Nebraska	W. H. Brokaw, College of Agriculture, University of Nebraska, Lincoln.
Nevada	C. W. Creel, College of Agriculture, University of Nevada, Reno.
New Hampshire	J. C. Kendall, University of New Hampshire, Durham.
New Jersey	H. J. Baker, College of Agriculture and Mechanic Arts of Rutgers College and the State University of New Jersey, New Brunswick.
New Mexico	W. L. Elser, New Mexico College of Agriculture and Mechanic Arts, State College.
New York	C. E. Ladd, New York State College of Agriculture, Ithaca.
North Carolina	I. O. Schaub, State College Station, Raleigh.
North Dakota	C. F. Monroe, North Dakota Agricultural College, State College Station, Fargo.
Ohio	H. C. Ramsower, College of Agriculture, Ohio State University, Columbus.
Oklahoma	W. D. Bentley, Oklahoma Agricultural and Mechanical College, Stillwater.
Oregon	P. V. Maris, Oregon Agricultural College, Corvallis.
Pennsylvania	M. S. McDowell, Pennsylvania State College, State College.
Rhode Island	George E. Adams, Rhode Island State College, Kingston.
South Carolina	W. W. Long, Clemson Agricultural College of South Carolina, Clemson College.
South Dakota	A. E. Anderson, South Dakota State College of Agriculture and Mechanic Arts, Brookings.
Tennessee	C. A. Keffer, College of Agriculture, University of Tennessee, Knoxville.
Texas	C. H. Alvord. Agricultural and Mechanical College of Texas, College Station.
Utah	William Peterson, Agricultural College of Utah, Logan.

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Vermont--------- Thomas Bradlee, University of Vermont and State Agricultural College, Burlington.
Virginia---------- J. R. Hutcheson, Virginia Polytechnic Institute, Blacksburg.
Washington------ S. B. Nelson, State College of Washington, Pullman.
West Virginia---- N. T. Frame, College of Agriculture, West Virginia University, Morgantown.
Wisconsin-------- H. L. Russell, director; K. L. Hatch, assistant director,[1] College of Agriculture, University of Wisconsin, Madison.
Wyoming--------- A. E. Bowman, College of Agriculture, University of Wyoming, Laramie.

Directors of Experiment Stations

Alabama—
(College station) Auburn: M. J. Funchess.
(Canebrake station) Uniontown: W. A. Cammack.
(Tuskegee station) Tuskegee Institute: G. W. Carver.
Alaska—Sitka: C. C. Georgeson.
Arizona—Tucson: J. J. Thornber.
Arkansas—Fayetteville: D. T. Gray.
California—Berkeley: E. D. Merrill.
Colorado—Fort Collins: C. P. Gillette.
Connecticut—
(State station) New Haven: } W. L. Slate, jr.
(Storrs station) Storrs: }
Delaware—Newark: C. A. McCue.
Florida—Gainesville: Wilmon Newell.
Georgia—
(State station) Experiment: H. P. Stuckey.
(Coastal plain station) Tifton: S. H. Starr.
Guam—Island of Guam: C. W. Edwards.
Hawaii—
(Federal station) Honolulu: J. M. Westgate.
(Sugar planters' station) Honolulu: H. P. Agee.
Idaho—Moscow: E. J. Iddings.
Illinois—Urbana: H. W. Mumford.
Indiana—La Fayette: G. I. Christie.
Iowa—Ames: C. F. Curtiss.
Kansas—Manhattan: L. E. Call.
Kentucky—Lexington: T. P. Cooper.
Louisiana—
(State station) University Station, Baton Rouge: }
(North Louisiana station) Calhoun: } W. R. Dodson.
(Rice station) Crowley: }
(Fruit and truck station) Hammond: }
Maine—Orono: W. J. Morse.
Maryland—College Park: H. J. Patterson.
Massachusetts—Amherst: S. B. Haskell.
Michigan—East Lansing: R. S. Shaw.
Minnesota—University Farm, St. Paul: W. C. Coffey.
Mississippi—A. and M. College: J. R. Ricks.
Missouri—
(College station) Columbia: F. B. Mumford.
(Fruit station) Mountain Grove, F. W. Faurot.
(Poultry station) Mountain Grove: T. W. Noland.
Montana—Bozeman: F. B. Linfield.
Nebraska—Lincoln: E. A. Burnett.

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[1]All general correspondence is conducted by the assistant director.

Nevada—Reno: S. B. Doten.
New Hampshire—Durham: J. C. Kendall.
New Jersey—New Brunswick: J. G. Lipman.
New Mexico—State College: Fabian Garcia.
New York—
(State station) Geneva: }
(Cornell station) Ithaca: } R. W. Thatcher.
North Carolina—State College Station, Raleigh: R. Y. Winters.
North Dakota—State College Station, Fargo: P. F. Trowbridge.
Ohio—Wooster: C. G. Williams.
Oklahoma—Stillwater: C. T. Dowell.
Oregon—Corvallis: J. T. Jardine.
Pennsylvania—
(College station) State College: R. L. Watts.
(Institute of animal nutrition) State College: E. B. Forbes.
Porto Rico—
(Federal station) Mayaguez: D. W. May.
(Insular station) Rio Piedras: F. A. López Dominguez.
Rhode Island—Kingston: B. L. Hartwell.
South Carolina—Clemson College: H. W. Barre.
South Dakota—Brookings: J. W. Wilson.
Tennessee—Knoxville: C. A. Mooers.
Texas College Station: A. B. Conner.[1]
Utah—Logan: William Peterson.
Vermont—Burlington: J. L. Hills.
Virginia—
(College station) Blacksburg: A. W. Drinkard, jr.
(Truck station) Norfolk: T. C. Johnson.
Virgin Islands—St. Croix: J. B. Thompson.
Washington—
(College station) Pullman: E. C. Johnson.
(Western Washington Station) Puyallup: J. A. Kalkus.[2]
West Virginia—Morgantown: H. G. Knight.
Wisconsin—Madison: H. L. Russell.
Wyoming—Laramie: J. A. Hill.

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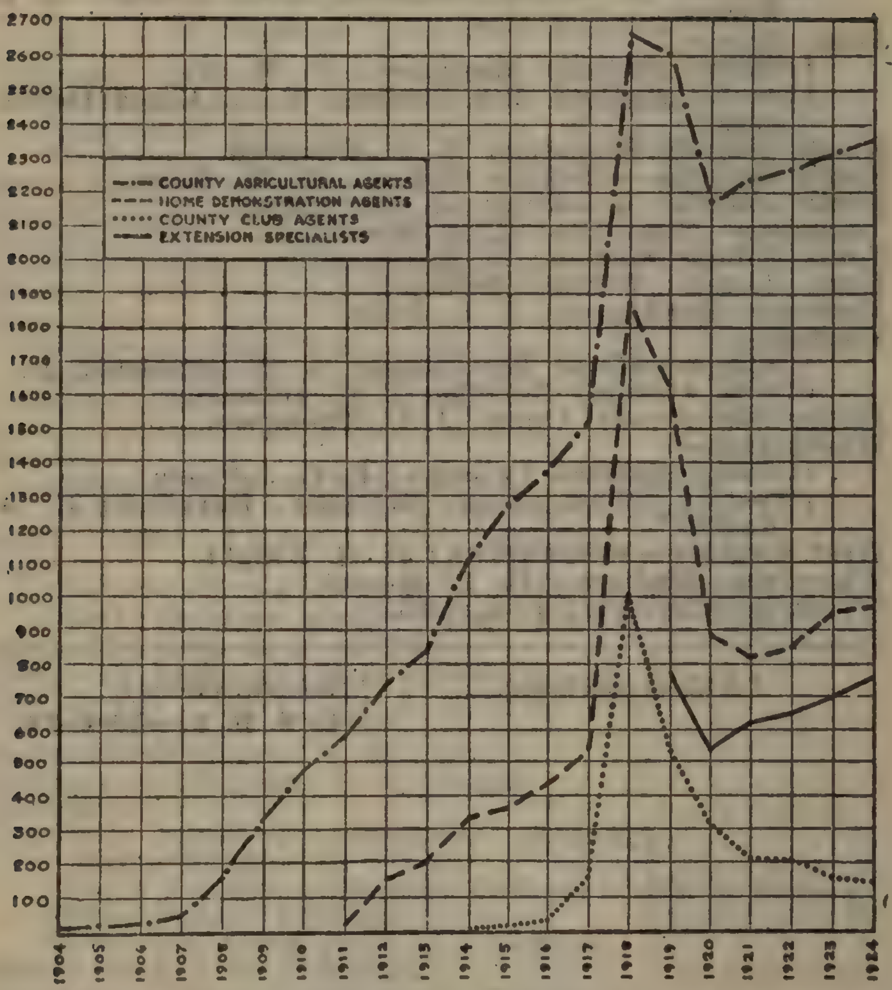
[1] Acting director. [2] Superintendent.

U. S. D. A.—10-1-26

County Extension Agents



Comparative growth in the number of county extension agents, 1904–1924, and of State subject-matter specialists, 1919–1924

POLICY AND RELATIONSHIPS

Duties of County Extension Agents

Statement of the Secretary of Agriculture Concerning the Relation of Federal Cooperative Extension Employees to Agricultural Organizations.—The act of Congress approved May 8, 1914, and supplemental acts thereto, established cooperative agricultural extension work between the Federal Department of Agriculture and State agricultural colleges. Section 2 of that act defines the work as follows:

"SEC. 2. That cooperative agricultural extension work shall consist of the giving of instruction and practical demonstrations in agriculture and home economics to persons not attending or resident in said colleges in the several communities and imparting to such persons information on said subjects through field demonstrations, publications, and otherwise; and this work shall be carried on in such manner as may be mutually agreed upon by the Secretary of Agriculture and the State agricultural college or colleges receiving the benefits of this act."

It is thus made clear that the work of the cooperative extension employees, whether county agents, home demonstration agents, boys' and girls' club agents, or other cooperative extension workers, is educational. These extension workers are public teachers paid with money largely raised from all of the people by taxation and are charged with giving instruction and practical demonstrations in agriculture and home economics. Their work covers the entire rural field, which includes economic production, economic marketing, and the development of better home, community, and social conditions.

As they are public teachers, it is not a part of the official duties of extension agents to perform for individual farmers or for organizations the actual operations of production, marketing, or the various activities necessary to the proper conduct of business or social organizations. They may not properly act as organizers for farmers' associations; conduct membership campaigns; solicit membership; edit organization publications; manage cooperative business enterprises; engage in commercial activities; act as financial or business agents, nor take part in any of the work of farmers' organizations, or of an individual farmer, which is outside of their duties as defined by the law and by the approved projects governing their work. They are expected, however, to make available to organizations such information as will be helpful to them and contribute to the success of their work.

The various Federal laws provide that cooperative extension work shall be conducted in such manner as shall be mutually agreed upon by the Secretary of Agriculture and the State agricultural colleges. By an agreement between these agencies an extension director located in each State is the representative of both the college and the department. He submits projects for extension work to the Secretary for approval.

In carrying out these projects the law provides that no Federal Smith-Lever money, except $10,000 per State, shall be paid to the States for cooperative extension work until * * * an equal sum has been appropriated for that year by the legislature of such State, or provided by State, county, college, local authority, or individual

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contributions from within the State, for the maintenance of the cooperative agricultural extension work provided for in this act.

Under a later act provision was made that * * * moneys contributed from such outside sources * * * shall be paid only through the Secretary of Agriculture or through State, county, or municipal agencies, or local farm bureaus or like organizations, cooperating for the purpose with the Secretary of Agriculture.

This makes it very clear that the law contemplates cooperation with farmers' organizations willing to cooperate in the work with which the cooperative extension agent is charged. It is the duty of the extension agent to render such assistance whenever possible in his teaching capacity to any agricultural organizations desiring it. Furthermore, the work of these extension agents can be the most effective where it is carried on with organized groups of rural people. It is entirely proper for any agricultural organization desiring to cooperate financially in the work of the extension agents to contribute funds for the support of such work, and these funds may be accepted legally by the extension service of the agricultural colleges and by the Federal Government for work on approved projects.

In short, it is the business of the extension agent to cooperate with all agricultural organizations which desire to cooperate on approved projects. If more than one organization exists in a county he must cooperate with all fairly and impartially in the educational work in which they are mutually interested.

The Department of Agriculture must necessarily consider in its administration of Federal cooperative extension funds the laws which have been passed by the various State legislatures in accepting these funds and under which agreements have been made with those States for conducting this work. If special provisions relating to the methods of cooperation with agricultural organizations or other agencies are contained in the States' laws, which do not conflict with the Federal laws, it is clearly the duty of the Secretary of Agriculture to accept such provisions in a cooperative project.

HENRY C. WALLACE,
Secretary of Agriculture.

AUGUST 25, 1922.

Scope of Extension Work in Agriculture and Home Economics (Resolution of Association of Land-Grant Colleges).—Extension work in agriculture and home economics in all the States is conducted under the provisions of the Smith-Lever Act. Section 2 of that act defines the work as follows:

"That cooperative agricultural extension work shall consist of the giving of instruction and practical demonstrations in agriculture and home economics to persons not attending or resident in said colleges in the several communities, and imparting to such persons information on said subjects through field demonstrations, publications, and otherwise; and this work shall be carried on in such manner as may be mutually agreed upon by the Secretary of Agriculture and the State agricultural college or colleges receiving the benefits of this act."

The wording and meaning of the above section are clear and definite. The work of county agents, home demonstration agents, boys' and girls' club agents, specialists, and other extension employees is strictly educational, since the act provides for the giving of instruction and practical demonstration. The Smith-Lever Act contemplated a broad and comprehensive work, which covers all

farm and home problems, including economic production, economic marketing, and the development of better home, community, and social conditions.

Duties of Extension Workers.—Extension workers, including county agents, home demonstration agents, boys' and girls' club agents, specialists, and other workers, are representatives of the State agricultural colleges and United States Department of Agriculture and should use their time and efforts in giving helpful information to the people of the various communities. These field agents are expected to carry the work of research departments to the people on the farm and in the home. They are expected to give information on cooperative enterprises and are within their field when they give information on methods of organizing to carry out the desired projects. On the other hand, the extension agents are not authorized and should not perform for individual farmers or for organizations the actual operations of production, marketing, or the various activities necessary to the proper conduct of business or social organizations. They should not act as organizers of farmers' associations, conduct membership campaigns, solicit membership, edit organization publications, manage cooperative business enterprises, engage in commercial activities, act as financial or business agents, nor take part in any of the work of farmers' organizations or of an individual farmer, which is outside their duties as defined by the law and by the approved projects governing the work.

Relation of Extension Workers to Organizations.—In order that extension workers may reach and assist the largest number of people, it is necessary for them to cooperate with organized groups of farmers and home makers. Lack of funds and workers makes it impossible to carry on projects with individuals. It is necessary, therefore, in the counties and communities, to have strong interested organizations with which to work effectively. In some States more than one agricultural organization exist. Where these organizations are interested in extension projects and are in a position to assist in the work, extension workers should give all possible cooperation and render impartial service. It is recognized that extension workers are public officials paid from public funds and should use their efforts in work of benefit to all. The best extension work is done where all active and interested agencies are enlisted in the extension program.

Political Activities of Federal Employees

Competitive employees, while retaining the right to vote and to express privately their opinions on political subjects, are forbidden to take an active part in political management or in political campaigns. This also applies to temporary employees, employees on leave of absence with or without pay, substitutes, and laborers. Political activity in city, county, State, or national elections, whether primary or regular, or in behalf of any party or candidate, or any measure to be voted upon, is prohibited.

Employees are accountable for political activity by persons other than themselves, including wives or husbands, if, in fact, the employees are thus accomplishing by collusion and indirection what they may not lawfully do directly and openly. Political activity, in fact, regardless of the methods or means used by the employee, constitutes the violation.

Political Assessments, Solicitations, and Discrimination by Federal Employees.—Sections 118, 119, 120, and 121 of the

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Criminal Code (see 35 Stat. 1110) provide that no legislative, executive, or judicial officer or employee shall solicit or be concerned in soliciting or receiving any money or contribution for political purposes from any other officer or employee of the Government; that no solicitation or receipt of political assessments shall be made by any person in any room or building occupied in the discharge of official duties by any officer or employee of the United States; that no officer or employee shall be discharged or demoted for refusing to make any contribution for political purposes; and that no officer or employee of the Government shall directly or indirectly give or hand over to any other officer or employee in the service of the United States or to any Member or Delegate to Congress any money or other valuable thing for the promotion of any political object whatever.

Section 122 of the Criminal Code provides that whoever shall violate any provision of the four sections shall be fined not more than $5,000, or imprisoned not more than three years, or both.

Presidential Officers.—Presidential appointees are forbidden by statute to use their official authority or influence to coerce the political action of any person or body, to make any contribution for a political object to any other officer of the United States, or to solicit or receive contributions for political purposes from other Federal officers or employees, or to discriminate among their employees or applicants for political reasons.

Otherwise, a presidential appointee will be allowed to take such a part in political campaigns as is taken by any private citizen, except that under departmental regulations issued by the State, Treasury, War, Navy, Interior, Agriculture, and Commerce Departments, and by the Interstate Commerce Commission, the Secretary of the Smithsonian Institution, and the Public Printer, he will not be permitted—

(1) To hold a position as a member or officer of any political committee that solicits funds.

(2) To display such obtrusive partisanship as to cause public scandal.

(4) To attempt to manipulate party primaries or conventions.

(4) To use his position to bring about his selection as a delegate to conventions.

(5) To act as chairman of a political convention.

(6) To assume the active conduct of a political campaign.

(7) To use his position to interfere with an election or to affect the result thereof.

(8) To neglect his public duties.

It is the duty of any person having knowledge of the violation of any of the foregoing provisions of the civil-service rules or Criminal Code to submit the facts to the United States Civil Service Commission, Washington, D. C.

UNITED STATES CIVIL SERVICE COMMISSION.

At the request of the Civil Service Commission the above is published for the information and guidance of all employees of the Department of Agriculture.

W. M. JARDINE,
Secretary of Agriculture.

APRIL 15, 1925.

Use of Federal Penalty Envelopes

The following information concerning the use of the penalty privilege of cooperative extension employees of the United States Department of Agriculture was pre-

pared March 1, 1926, by the Post Office Department, Third Assistant Postmaster General, Division of Classification, in conjunction with the Office of Cooperative Extension Work:

(1) The law, embodied in section 485, Postal Laws and Regulations, restricts the use of penalty envelopes to "officers of the United States Government" solely for the purpose of transmitting in the mails free of postage "matters relating exclusively to the business of the Government of the United States." As employees of the United States Department of Agriculture, Extension Service, cooperative extension agents, such as county agents, county home demonstration agents, county club leaders or agents and the State leaders of such agents, farm-management demonstrators, and farm-forestry agents are officers of the United States Government and are entitled to use penalty envelopes in sending matter in the mails free of postage in pursuance of their duties as employees of the Department of Agriculture.

(2) The fundamental viewpoint to be considered is that such employees have the right to use penalty envelopes, cards, or labels only because they are employees of the United States Department of Agriculture. They should exercise the penalty privilege only for matters arising in connection with those extension enterprises which are covered by the terms of their commissions from the Department of Agriculture. Such persons may not use penalty envelopes, cards, or labels to transmit free in the mails matters sent in behalf of the agencies or institutions (such as the State department or college of agriculture, farm bureau, etc.) with which the United States Department of Agriculture is cooperating and on which such agencies or institutions should properly pay postage.

(3) All matter mailed free by cooperative extension employees should bear a heading which clearly indicates the participation of the United States Department of Agriculture in the work undertaken. The approved form for such heading is as follows, and may be adapted to meet the needs of each State and county:

COOPERATIVE EXTENSION WORK

IN

AGRICULTURE AND HOME ECONOMICS

STATE OF (MASSACHUSETTS)

State Agricultural College,	Extension Service,
U. S. Department of Agriculture,	County Agent Work,
(Other State or county organization)	(Springfield, Mass.)
Cooperating	

(4) Section 485, Postal Laws and Regulations, prescribes the particular indicia which shall appear on penalty envelopes. Those furnished by the Department of Agriculture for use by its employees in cooperative extension work bear the following indicia:

U. S. Department of Agriculture Extension Service Office of Cooperative Extension Work Washington, D. C.	Penalty for Private Use to Avoid Payment of Postage, $300

Official Business

No other matter, such as an employee's local return card, etc., should be added, but the envelopes should be used as furnished by the Department of Agriculture.

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(5) Matter to be mailed free by agricultural extension employees should consist, in the main, of the giving of instructions and demonstrations in agriculture and home economics, imparting information in regard thereto, announcing meetings called by the employees for such purposes, and otherwise promoting cooperative extension work as a Federal project. This embraces matter such as the following:

(*a*) Bulletins, pamphlets, etc., issued by the United States Department of Agriculture.

(*b*) Official correspondence with the Department of Agriculture, leaders or directors within the State, supervising agents and other field employees of that department engaged in similar work, relating entirely to official business for which the sender received the Federal appointment.

(*c*) Letters of instruction to farmers who are carrying on demonstrations.

(*d*) Notices of meetings to be held in furtherance of cooperative extension work as a Federal project and of special demonstrations for the purpose of giving information to farmers or their families relative to demonstrations conducted under the supervision of the employees.

(*e*) Advice to farmers and their families in answer to inquiries regarding some feature of agriculture or home economics promoted by the employee in his capacity as a Federal employee.

(*f*) Bulletins, pamphlets, etc., issued by State agricultural colleges or experiment stations containing valuable information on agriculture and home economics which an employee desires to furnish to particular persons who have made requests for such information or with whom he is conducting some demonstration or special work, when accompanied by a letter of transmission signed by him with his official title.

(*g*) Other matter strictly promoting cooperative extension work as a Federal enterprise.

(6) Penalty envelopes should not be used in mailing any private matter whatever, and the entire contents of letters, circulars, etc., mailed free should relate exclusively to cooperative extension work in agriculture or home economics as a Federal project. Cooperative employees should not use penalty envelopes in conducting actual service work, such as:

(*a*) Buying or selling products for individual farmers, dealers, shippers, etc., or groups of farmers, etc.

(*b*) Recommending products of particular firms or individuals.

(*c*) Sending for catalogues, price lists, seed, implements, etc., for farmers, etc.

(*d*) General distribution of bulletins, circulars, or other printed matter of colleges or stations or other organizations.

(*e*) Distributing commercial, religious, or political announcements or advertisements.

(*f*) Soliciting membership or funds for the support of any organization or association.

(*g*) Sending out notices of meetings of organizations of farmers or business men.

(*h*) Sending out indiscriminate announcements of farmers' meetings.

(*i*) Relieving organizations, institutions, or other agencies from paying postage on matter issued in the interest of such organizations, institutions, or other agencies and which is properly chargeable with postage.

(*j*) Promoting any organization with functions other than the promotion of cooperative or departmental extension work in agriculture or home economics.

(*k*) Mailing newspapers or periodicals or publications similar thereto.

(*l*) Sending catalogues or announcements of State, county, or other fairs, or prize lists of such fairs or other prizes.

(*m*) Mailing matter relating to any meeting, services, project, etc., in connection with which money is required to be paid.

(*n*) Promoting any enterprise other than Federal cooperative extension work.

(7) (*a*) Correspondence with autograph signature of an agricultural-extension employee may be mailed sealed, but all other matter must be left unsealed and should be mailed only at the post office designated for that purpose. (*b*) Letters and circulars mailed free by cooperative extension employees should not be signed by any person except an authorized agent of the United States Department of Agriculture, who should affix, in addition to his name, his official title indicating in what capacity he is an officer of the United States Government and thereby entitled to use the penalty privilege.

(8) (*a*) Cooperative extension employees may not use penalty envelopes in promoting the interests of local, county, State, or national farm organizations, except those which are organized for the exclusive purpose of promoting cooperative or departmental extension work in agriculture or home economics. (*b*) When circulars, letters, etc., which in fact relate to the business of the Government of the United States are to be mailed free by such employees, the salutation, contents, and complimentary ending thereof should not be in such form as to indicate that the matter relates to the business of a private organization or agency. (*c*) All matter mailed free should be prepared in such manner as clearly to indicate that the subject matter relates to an enterprise for the furtherance of which the employees received their commissions.

(9) The provisions of section 491, Postal Laws and Regulations, in regard to the free mailing privilege accorded directors of the extension division of State agricultural colleges do not apply to county agents, home demonstration agents, or other agricultural extension employees of the United States Department of Agriculture. This also applies to sections 492 and 493, Postal Laws and Regulations, pertaining to the free mailing privilege of directors of agricultural experiment stations.

(10) Correspondence of an informational character preliminary to the establishment of local organizations such as livestock, wool, and other marketing associations, etc., designed to promote cooperative agricultural extension work in agriculture and home economics may be mailed free, but when such an association begins to function its activities should then be handled by its own officers, and correspondence in regard thereto is no longer entitled to be mailed free but should be sent under postage. In other words, cooperative extension employees may use penalty envelopes for mailing matter free in order "to show the farmers how to organize, but it is not their function to act as business agents of the farmers or as agents of cooperative marketing or other organizations."

(11) (*a*) Cooperative extension employees are not entitled to send out circulars of inquiry in penalty envelopes unless they are instructed to do so by the director of cooperative extension work in their State, and penalty envelopes, tags, or labels should never be furnished to farmers or others to be used in sending any commodity through the mails. (*b*) A self-addressed penalty en-

velope or card bearing the reply address of the authorized employee of the United States Department of Agriculture who furnishes it may be sent out to farmers and other persons from whom official information is desired, provided such information is to be used strictly in furtherance of the work for which the employee received the Federal appointment. Caution should be used in this respect for fear of the abuse of the privilege by uninstructed individuals.

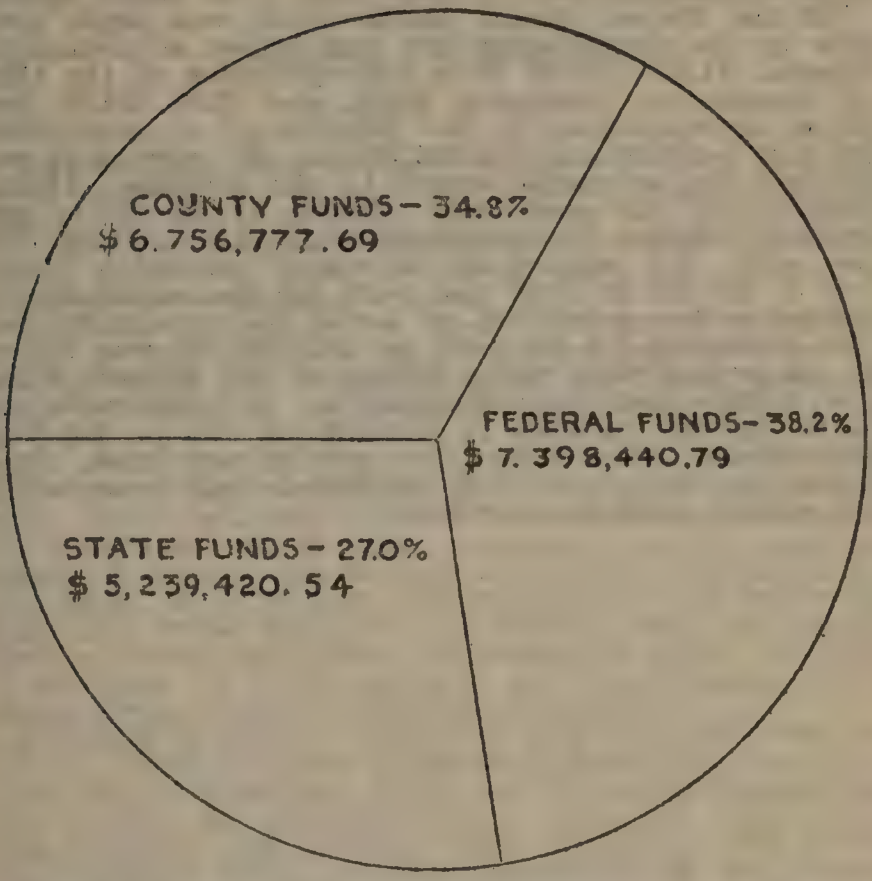
(12) In order to be mailable in penalty envelopes, material relating to boys' and girls' club work should bear the heading prescribed in paragraph 3 of this circular and be prepared in such manner as to emphasize primarily the demonstrational features of such work, and any mention of social activities such as picnics, parades, baseball games, hay rides, etc., must be merely incidental thereto. It should be made clear that the purpose of such social activities is to reenforce the demonstrations being conducted.

(13) Penalty envelopes may not be used to send in the mails a publication similar to a newspaper or other periodical within the commonly understood meaning of that term. Such material may be printed as newspapers and entered as second-class matter under the act of March 3, 1879, embodied in section 394 of the Postal Laws and Regulations, which extends the second-class mailing privilege to publications which have a "legitimate list of subscribers" and are not "designed primarily for advertising purposes, or for free circulation, or for circulation at nominal rates." Application for such entry should be made on Form 3501, which may be obtained from the postmaster.

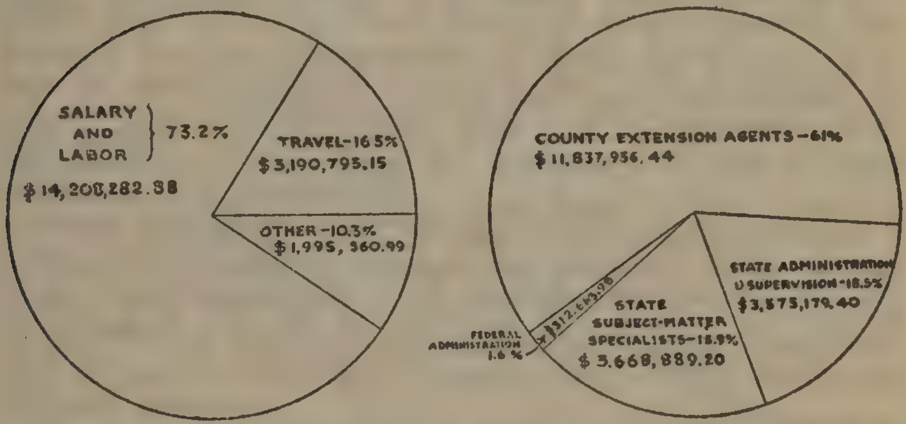
(14) The mere wording of circulars, letters, etc., does not determine their mailability free of postage. The purpose of the employees in sending the matter, the circumstances and conditions under which it is being sent, as well as the subject matter thereof, should be considered in determining what matter is entitled to be mailed free, and only such matter as relates to their work as employees of the United States Department of Agriculture should be so mailed. In order to avoid confusion and misunderstanding and to eliminate the indiscriminate use of penalty envelopes, postmasters should submit specimens of all doubtful matter to the Third Assistant Postmaster General, Division of Classification, Washington, D. C., for examination and determination as to their mailability free under the penalty privilege.

R. S. REGAR,
Third Assistant Postmaster General.

FINANCES



Sources of all funds used for cooperative extension work during the year ended June 30, 1924



Expenditures of all funds used for cooperative extension work during the year ended June 30, 1924

The total funds from all sources expended for cooperative extension work during the fiscal year ended June 30, 1924, was $19,394,639.02, or practically the same as for the previous year. Of this amount, 38.2 per cent, or $7.398,440.79, was contributed by the Federal Government, exclusive of the use of the penalty envelopes, and

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27 per cent, or $5,239,420.54, was derived from State appropriations of the agricultural colleges and other State agencies. The remaining 34.8 per cent, $6,756,777.69. came from county appropriations for extension work and from contributions by local organizations and individuals. More than 94 per cent of all funds used for cooperative extension work in 1924 came from public sources.

Of the Federal funds, $5,859,605.01 was made available by the Smith-Lever law and others supplementary thereto, $1,304,514.80 from appropriations to the Office of Cooperative Extension Work, and $234,320.98 from other appropriations to the Department of Agriculture. Of the total funds, $11,837,956.44 (61 per cent) was allotted for extension agents in the counties: $1,591,-104.54 (8.2 per cent) was allotted at the State agricultural colleges for administration; $1,984.074.86 (10.3 per cent) for supervision of county extension forces; and $3,668,889.20 (18.9 per cent) for the employment of subject-matter specialists to assist the county workers. The remaining 1.6 per cent, or $312,613.98, was for use in connection with the activities of the Federal Extension Service located at Washington. A considerable part of the money expended in Washington and at the State agricultural colleges was for penalty envelopes, report forms, circulars, and other supplies largely consumed by the county extension workers.

PROGRAM DEVELOPMENT

Programs of Work

Two distinct types of programs are needed in extension work, namely, a long-time agricultural program and an annual extension program. The former is the basis of the extension program over a period of years. The latter varies more from year to year as goals are reached or changing circumstances dictate.

Agricultural Program.—A basic agricultural program is a list of the practices which are recommended as the best solutions for important farm and home problems. Such practices can be determined only after close study of the factors which make up a general problem. Thus each broad problem, like the cost of producing milk, comprises several underlying problems, such as high feed costs, poor cows, and high labor costs. Such factors and all conditions which have dictated present practices should be known and understood. Then consistent improvement, both present and future, in each important farm and home enterprise or activity may be sought. Then a logical and integrated outline of better practices as solutions for these problems can be developed. This constitutes a rational agricultural program.

Extension Program.—Extension programs are made annually. This involves a selection from the basic program of the practices which are to be emphasized, together with the determination of the most appropriate plan (project) for teaching these practices. The conditions vary so that a blanket application of one project can not be made. The circumstances and abilities of each group to be taught should be known and understood, and projects designed which will fit these conditions. Thus, for example, the cow-testing association project is the only one of its kind found in most extension programs. Yet the circumstances of large groups of dairymen in many sections are such that this project does not fit the conditions. Since the practices taught by this project are important, new and better-fitted plans for teaching these must be developed if the average dairyman is to be reached.

Many extension programs fall short of the mark because they include projects which are not based upon a thorough analysis of underlying problems and varying needs and circumstances; or because successive extension programs do not attack a problem in a logical and orderly manner. The best safeguard against "patent projects" and haphazard extension programs is a strong basic agricultural program.

An example of the relation of an extension program to an agricultural program is shown below. The basic problem given is the high cost of producing milk. The factors which make up that problem are poor cows high feed costs, and high labor costs. The practices listed are practical solutions for these and constitute the long-time program. The extension program lists projects which have been designed to teach some of these solutions.

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Agricultural Program (Long time)	Extension Program (Current year)
Test cows for production	
Introduce better bulls	Better bull campaign.
Introduce higher-producing cows	Heifer calf club.
Feed more clover	
Feed more alfalfa	Alfalfa campaign.
Feed better-balanced rations	
Decrease cost of silage	
Increase size of herds	
Add other farm enterprises	Demonstrations of brooding and rearing chicks.

Determination of Agricultural Program

The steps involved in determining an agricultural program are:

(1) Identification and location of the problems.
(2) Size and importance of the industry or activity.
(3) Trends and future developments.
(4) Phases or factors which make up the problem.
(5) Present practices generally followed.
(6) Circumstances dictating present practices.
(7) Practical solutions for problems, including source of supplies.

Use of Steps.—The use of these steps is illustrated below. The ground covered in getting facts on the problem of high costs of milk production, and the conclusions and recommendations which may be based upon these facts are shown:

(1) Farm-management surveys, cost accounts, and testimony of leading dairymen show costs of producing milk to be uniformly high. The dairyman who sells to distributor or wholesale trade is most affected by the resulting low net gains.

(2) Studies of census statistics by towns, farm-management surveys and accounts, milk shipments, and farm-to-farm surveys show by towns the number and distribution of farms producing milk, the quantity produced, income from milk, size of herds, and quantity of feed purchased, and indicate farms where dairying for wholesale market is the major enterprise.

(3) The large urban population contiguous to the milk-producing sections indicates, as do such factors as small area of tillable land available, and competition of other areas in producing meat and staple food crops, that there will always be a demand for fluid milk of high quality. The conclusion is that in the areas mapped the production of high-quality fluid milk will always be a major enterprise.

(4) The problem of high costs of producing milk, as shown by surveys, cost-account studies, questionnaires, and conferences with leading dairymen, includes the following factors:

(*a*) Cows inherently low producers.
(*b*) High feed costs.
(*c*) High labor costs.

(5) Farm-to-farm surveys, community program making, and contacts with leading dairymen show that the following practices are usual:

(*a*) Small herds maintained.
(*b*) Replacements purchased.
(*c*) Poor bulls are kept.
(*d*) Insufficient forage is grown.
(*e*) Long rotations.
(*f*) Little or no legume hay is grown or purchased.

(*g*) Concentrates and grain largely depended upon.
(*h*) Pastures are not kept up.
(*i*) Dairying is chief enterprise.
(*j*) Operations in other enterprises are small.

(6) The circumstances and conditions which are largely responsible for these practices have been found by means of farm-to-farm surveys, questionnaires, and community program development. These show the following points:

(*a*) Small area of tillable land per farm.
(*b*) Difficulty of making hay.
(*c*) High cost of lime.
(*d*) Rocky, wooded pastures difficult to improve.
(*e*) Small quantity of manure available for tilled land.
(*f*) Lack of efficient farm implements.
(*g*) Opinion prevails that it does not pay to raise calves.
(*h*) Average farmer thinks he is too old to start new enterprises, as orcharding or poultry raising.
(*i*) Farm primarily a home, not a business, so enterprises are small.

(7) The solutions offered in terms of better practices recognize conditions mentioned. They are based likewise upon demonstrated facts and can be adopted by the majority:

(*a*) More farmers can raise their own replacements since farm studies show that the more successful farmers are doing so.
(*b*) Better bulls are needed.
(*c*) The dairy farmer who has for sale calves or heifers of good breeding thus adds a profitable enterprise. Each farmer could manage from three to eight more cows per farm and decrease labor costs.
(*d*) Success with alfalfa has been demonstrated, and since this fits in with a long rotation every farmer should have at least 1 acre of alfalfa for every cow.
(*e*) The rations may be improved and costs decreased by feeding the standard rations.
(*f*) Costs of producing hay and silage may be decreased by the introduction of labor-saving machinery and methods.
(*g*) Simple tests and records of production will help the farmer cull out poor cows and breed better ones.
(*h*) For replacement only cows of known production or purebred heifers with production records of parents should be purchased.

Determination of Extension Program

In building a local program of extension work, the agent makes application of the agricultural program to specific community conditions and circumstances. In addition, he provides opportunities to meet important local problems which may not be included in the broader program. If program making is carried on with committees or groups which represent the various communities, this involves planning with the local people how the objectives are to be reached. Local leaders also need to be selected and trained to help in attaining the goals.

Use of Steps.—The following steps are involved:

(1) Draft tentative county program by communities.
(2) Obtain revision and approval at college.
(3) Work with community leaders to consider local problems and to adapt county program locally.
(4) Agent revises county program and outlines plans of work.
(5) Arouse community interest in program making.
(6) Hold community meeting to approve program and discuss ways and means of carrying it out.

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(7) Keep public informed on program and plans of work.

(8) Measure results and revise program annually.

Use of Outline.—The use of this outline is illustrated as follows:

(1) The tentative county program is blocked out project by project, community by community. It is based upon the following:

(*a*) The agricultural program.

(*b*) Past work and results.

(*c*) Present needs, local and county-wide.

The agent needs to have much local data on the various industries and activities and must shrewdly analyze the facts in much the same way as they were outlined when the agricultural program was developed. The blind can not lead the blind. It is for him to study and analyze conditions and problems if he wants to lead others to make a program. This may require local enterprise surveys to ascertain local situations and needs. The tentative program may well be reviewed and approved by a representative county extension committee.

(2) This program is reviewed next by the immediate supervisor of extension agents. It then can be cleared through the various specialists concerned or committees of specialists, supervisors, and agents, then revised and approved by the director of extension. Tentative arrangements for help from specialists are made, and definite project plans outlined by them are obtained.

(3) The agent now studies each community to find suitable leaders in each activity and to arrange meetings with them to work out the following:

(*a*) Map community and local enterprises.

(*b*) Identify problems.

(*c*) Review present practices and circumstances.

(*d*) Consider ways and means of advancing projects, including prospective leaders.

(*e*) Consider needed local sources of supply of materials, equipment, and stock.

(*f*) Approve program with suggested changes.

(*g*) Plan for getting approval of community.

(4) These steps covered, the agent now revises the entire program and prepares detailed plans for advancing the major activities, that he and the leaders may more intelligently guide community interest in program making and in outlining the ways and means to be employed in reaching the goals set. Without a detailed plan and calendar for each line of work he can not effectively guide community program making, or outline how goals are to be reached.

(5) The interest of the communities in the problem of developing a sound representative program must be built up. Long before the community program-planning meeting is held the agent, by means of news notes, subject-matter articles on local and State problems, circular letters, and meetings with commodity groups and associations, informs the general public, arouses attention, and sustains interest in his studies, analyses, and plans. Otherwise, the part the local people will play will be superficial, perfunctory, and not of any duration. Program making is an educative process, and its development needs to be spread over a much longer period during the year than it is at present.

(6) The agent calls the community program meeting for the purpose of giving the local people a chance to go over the work of the agent and the leaders; to learn of problems of community-wide importance; to bring out

necessary local adjustments; and to win community-wide approval. Following are the essential things to plan for:

(*a*) A representative meeting.

(*b*) A program of procedure with definite objectives.

(*c*) Aid from well-coached leaders.

(*d*) Use of charts, data, illustrations to show importance of enterprises and problems to be met.

(*e*) Directed discussion of proposed remedies and ways and means of teaching them.

(*f*) Acceptance of program by community.

(*g*) Approval of plans of work.

(*h*) Selection of necessary leaders.

(7) After the program meeting the agent makes and uses many opportunities for keeping the people informed on the program of work. County and community programs of work are kept before the people constantly by means of news letters, the local press, bulletins, displays, and exhibits. News on the progress of the plans of work and results in terms of each project are sent out continually, that the general public may become more conscious of the program as their program and become better and better informed on the improvement it seeks. Quite naturally they also become more helpful in making future programs.

(8) The successive annual program-planning meetings are used to measure results in terms of the goals set for each piece of work, and to reset these goals accordingly. These meetings also give opportunity to consider any necessary changes in the plans of work for each project. As the goals are reached and as changing circumstances require, new lines of work are added as suggested by the basic agricultural program. Many agents find that the most effective direction can be given this effort by observance of the following rules:

(*a*) Procure with the introduction of a project a list of the names and requirements of all individuals for whom the practice is appropriate.

(*b*) After a suitable period of sustaining interest and stimulating desire, obtain from as many as possible on the list above a declaration of intention to adopt the practice.

(*c*) Give follow-up service to all those who have subscribed, that they may learn and adopt the practice effectively.

(*d*) Obtain a report of results obtained by each individual, together with requests for further help.

(*e*) Compare with original list, reset goals, and revise teaching plans accordingly. Most projects are dropped too soon because the facts about the real spread of practice are not known.

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METHODS (TEACHING)

Objectives

General.—Good extension teaching is dependent upon the following:

(1) A clear understanding of the responsibilities of the extension agent as a teacher.

(2) A working knowledge of the principles of teaching and the factors that condition learning.

(3) Correct diagnosis of local situations.

(4) Determination of desired changes in practices.

(5) Service and supply in terms of material and equipment needed.

(6) Well-planned application of the principles of teaching, that desired changes may be brought about.

The extension agent is primarily a teacher—not a service agent. Therefore he has a greater responsibilty than that of extending subject-matter information. Good extension teaching definitely moves groups of people who have a common problem to improve their situations by adopting recommended practices. It is the agent's concern to find these problems, to determine economical solutions and sound practices, and to plan his teaching so that people will want to make the desired changes, and will acquire the necessary skill, knowledge, and attitude.

Better Practices.—Effective extension teaching requires that the recommendations be reduced to the simplest form. The teaching should begin with practices, not principles, for the average man can not apply principles to improve situations. Likewise, it is better to teach single practices. People learn one thing at a time. Learning is a habit-forming process. Therefore, the wise extension teacher does not try to reach the majority by presenting related and segregated facts and principles in logical order on the lesson or lecture plan. The psychological approach is the better approach. In this instance the extension teacher analyzes the problem. He segregates principles and subject matter so that progress in bringing about desired changes will be orderly and logical. He teaches practices, taking one step at a time. Since suggestion is the more potent, he depends less upon argument, but uses a variety of means and agencies to suggest and hold the idea of a desired change before people. Each means and each agency reiterates and resuggests facts concerning the practice. Each reenforces the others in driving home the idea.

Practices versus Organized Knowledge and Appreciations.—This emphasis is placed on teaching practices, since the agent is charged with teaching large numbers of people. He can not organize the masses into classes to teach them organized bodies of knowledge and appreciations in a formal way, even if such teaching were correct and desirable. The county extension agent is not a classroom teacher. Moreover, his contacts with the great mass are not close or long sustained. He is forced to use many chance and indirect contacts and relies upon means and agencies which broadcast an idea and hold it before the rural people.

These people want facts and information that they can use now, and not knowledge to store up for the future. They have situations to meet and problems to solve. The extension agent must be prepared to teach practical solutions for these problems—better practices. Each practice learned makes the individual better fitted by experience and discovery to learn other practices. Gradually he

acquires some organized knowledge and the proper appreciations and ideals that will help him to solve problems and still further to improve his situations. The extension teacher should take the farmer and his problems as they are and teach through his experience—step by step, practice by practice.

If the practice is one that will benefit a large number of people, the agent must organize his use of extension means and agencies so that certain attitudes are developed in the minds of those he is trying to reach. If this is well done, not only will more people be influenced to recognize their problems and to adopt suggested practices. but they will incidentally acquire more information as well as appreciation and ideals. Well-planned extension teaching, therefore, is based upon developing the following attitudes in the minds of the mass, namely, (1) attention, (2) interest, (3) desire, (4) confidence, (5) action, and (6) satisfaction.

These imply that the attitudes, feelings, and reactions of those to be taught are known and understood. Their ruling interests and emotions must be gauged properly. Their habits of thought as well as habits of practice must be appreciated. Their arguments must be foreseen. Only then can choice and use be made of the most appropriate teaching means and agencies. Each means, namely, each circular letter, news article, poster, slogan, meeting, demonstration, tour, or project leader, is chosen and used for the special part it plans in developing these attitudes. Some are used to win attention and interest. These are reenforced by others which create confidence and desire. All help to hold the main idea—the better practice—before individuals. Finally they move individuals to adopt the better practice. The ultimate goal is satisfaction with this act. Therefore the means employed must teach the individual what and how to do as well as stimulate his interest. Quite obviously the practice must be sound. It must fit a real need. The farmer must be successful with the new practice—must get the results anticipated. His success will bring satisfaction. Then will come desire to learn still more.

Attitudes

Attention.—Repetition, constant repetition, is the first rule in successful extension teaching. This is particularly important in the first stages. Therefore more frequent and varied use of certain teaching agencies are used to get the attention of individuals. Motion, change, intensity, size, color—all should be employed to win attention and make entry for the idea in the mind-stream of the farmer. The following agencies are especially appropriate: Exhibits, displays, method demonstrations, motion pictures, pageants and plays, mock trials, slogans, posters, and prize poster and slogan contests.

Interest.—Rules which govern the choice and use of means and agencies to build and sustain interest are:

(1) Give information about the thing.

(2) Create activity toward it.

People become interested in something which they think will help them to meet their needs and difficulties. Choose means, therefore, which impress people with the fact that they have the problem and that the recommended practice will solve it for them. Here, too, some use can be made of argument and reason. Elsewhere reliance is placed largely upon suggestion. Moreover, means and agencies which engage the activity of people should be used early in the teaching effort. The following means and agencies will help to give information about the thing: Result demonstrations, records of results, testi-

monials, subject-matter articles bulletins, circulars, lectures and talks at meetings, program-planning meetings, radio talks, tours.

The following means have value in creating activity toward a thing: Slogan, essay, and poster contests, pageants and plays, surveys, and appointment of committeemen or project leaders to help with organization or in conducting the above.

Desire.—A desire is a want. To make this want felt and to insure action, proper appeals must be made to feelings and emotions. The farmer must see himself practicing what has been recommended, must feel himself in possession of the better stock, or see machinery. Skillful teaching will help him to envisage and to feel the benefits the new practices will bring him. The following agencies have been useful: Exhibits of the thing desired, tours to farms which have adopted the practice, "before and after" pictures and displays, participation in method demonstration, circular letters which suggest benefits, and published lists or honor rolls of people who have adopted a practice.

Action.—Desire should be followed by action. This implies that when desire has been created the farmer may quickly and easily satisfy this desire. The seeds, fertilizer, lime, chemicals, machinery, devices, or other necessary supplies and material should be made available locally at reasonable prices. Desire may then be turned into action by training committeemen to take orders for material or stock. Some spread of practice may be obtained by urging other people to adopt the practice. Enrollment cards are used with good effect in procuring action. These, directly or indirectly, pledge the signer to adopt the recommended practice. They are followed by a survey to show how much was done by each person enrolled, how carefully directions were followed, what results were obtained, what further help is needed by the individual. Then a true check on accomplishment and satisfaction is sure.

Satisfaction.—Satisfaction may be stimulated by keeping the results before the public. Personal mention in the form of news notes of those who adopted the practice or published honor rolls of those who have enrolled also foster local pride and satisfaction. A meeting of all those who have adopted an important practice for the purpose of discussing results and future needs also works well. Whatever the agent can do in the way of a personal visit to each cooperator, personal letter, or telephone calls, will contribute much to make individuals win success with the practice. Seasonal reminders in the form of circulars or bulletins also help to sustain interest and to maintain satisfaction.

Confidence.—The development of confidence must accompany the building of the other attitudes. It should grow in intensity as desire is created, and this is followed in turn by action and satisfaction. A wide use of demonstrations and testimonials from local people will help much. The way in which the agent uses all the agencies, however, is the best measure of the maintenance of confidence. Confidence is a fragile thing. Once lost, it is the more difficult to regain. Therefore the agent must nurture and safeguard it in every stage of his teaching.

Plans of Work

Well-outlined plans and calendars of work are necessary if the teaching is to be successful. For these plans each means and agency to be used is listed, and details

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of how and when these will be used are outlined. Without detailed procedure continuity and systematic work can not be maintained. Following is an outline of the most important steps to be taken:

(1) Provide a sure and economic supply of material needed by farmers.

(2) Awaken interest of leaders and get approval of tentative plans.

(3) Organize and train leaders.

(4) Survey farms to locate farmers who would benefit by adopting practice.

(5) Choose and use means and agencies to attract attention of rural public.

(6) Same to develop interest.

(7) Same to create desire.

(8) Same to reenforce others and to instill confidence.

(9) Same to procure favorable action by number of persons set in goal.

(10) Measure results.

(11) Choose and use means and agencies to maintain satisfaction.

(12) Revise plans for ensuing year.

Means and Agencies

Written or Printed—*Posters.*—Illustrated posters are used wherever a complete chain of means and agencies is maintained. They are particularly valuable in attracting the attention of the passer-by. Posters also serve to prepare the mind to receive other impressions of the same truth, which is the central idea of a project. Most posters are not studied, so they must be designed to catch the eye and to drive in the main idea. A large half-tone or line drawing, a slogan in large letters, and a suggestion which will lead to action are about all a poster will hold if picture and text are to be allowed sufficient background or white and black space. Color is important, since it compels attention and makes the central thought stand out.

The following items give the principal steps to be considered in using posters: (1) Purpose, (2) kind printed or drawn, (3) funds, (4) poster contest, which includes rules, committees, awards, and cooperation of schools, (5) procuring pictures, (6) text and design, (7) use and location, which includes roadsides, buildings, and displays, (8) number, (9) distribution, and (10) news notes.

Press—*Mediums.*—The public press—both the daily and the country weekly—is one of the best means of giving out information regarding results of extension work. There are 2,200 dailies, 11,000 country weeklies, and 200 farm and home journals in the United States. Most of these papers are read with confidence by their subscribers.

In the campaign for agricultural and home improvement the country weekly is a valuable aid to the county extension agent. The well-conducted country weekly aims to satisfy the curiosity of the community in a constructive way. It accomplishes much toward getting the people in various parts of the county acquainted with one another's doings. Each of these country weeklies has from 500 to 2,000 subscribers, who form its reading audience. The extension agent, if he supplies the right kind of material to the editors of such papers, can make these subscribers regular and interested readers of news regarding extension happenings and results.

What is extension news?—The country editor and the county extension agent, both having the interests of the community at heart, should be allies. Cultivate the

acquaintance of editors and reporters. Every extension project in a county and every phase of such a project, if properly prepared for the press, will make a good news story. Editors do not want propaganda. They want news stories of current happenings, practical informational articles, feature stories of specific instances and experiences, human-interest experiences in story style, and informal items. The preparation and placing of such news is one of the recognized essentials in carrying out every major extension project in a county and should not be regarded as being merely an occasional by-product of the project.

Preparation of stories.—Any extension worker can learn to write passably good news stories in a short time. In a four-lesson correspondence course in news writing for the country paper (Course 26, Writing for the community paper, Ohio extension service), Russell Lord, formerly extension editor in Ohio, gives the following simple rules for news writing:

(1) Report things when they happen.
(2) Put important things first.
(3) Keep your own personal opinion out of the story.
(4) Let the straight facts tell the story.
(5) Write short and direct sentences.
(6) Write as you would say it, but more correctly, directly, and clearly.
(7) Use essential names—see that the initials are correct.
(8) Read over what you write. Check to see if you have answered who, what, when, where, and if necessary, how and why. Cut out every word not needed.
(9) Be brief. Quit as soon as you conscientiously can. Your job is to satisfy curiosity, not to deliver a lecture.

In writing a story, typewrite it in double or triple space form. Editors prefer typewritten copy to that written in longhand. If longhand must be used, write legibly on ruled or regular copy paper. Leave space at the top of the first page for the heading. The editor usually prefers to write this himself. At the end of each article write the word "end," draw a line, or indicate in some manner that the story is completed.

In contributing to the country weekly the extension agent often may use good subject-matter material sent out by the State extension service. Such information is always more valuable when it is reenforced with a good local story of the successful application of the method or methods recommended. Such a story carrying the successful experience of a local farmer is worth twice as much as a statement limited to recommendations made by the State extension service or the county extension agent.

Do not become discouraged when advertising or news of special public interest temporarily occupies the space in which you wish extension news to appear. Soon or late the supply of news runs short and the call for good copy comes. When this happens have a supply of news ready to print. Get news material into the local papers so regularly that the readers will miss the extension news when it is crowded out. It will be only a short time until it will be a regular feature of each issue.

When any news items or stories regarding extension activities are written, send a carbon copy in with the written report to the State office. There should be at least one such item each week. Each item should answer the questions "who, what, when, and where" and, if necessary, should tell "how" and "why." Such local extension news may also be good State news and frequently contains items of regional, if not national interest.

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When a big extension event takes place, give it wide news distribution at once. For instance, if some one in the county wins a State prize or an out-of-State prize, telegraph or telephone the news to your State extension service, and the State extension editor will give the story the distribution it deserves.

Slogans.—Slogan contests often fill a logical place in the chain of means and agencies which should be constructed to advance an important project. Like essay and poster contests, they stimulate attention, teach facts about the recommended practices, and sustain interest in the work. The following outline will guide extension agents in the conduct of slogan contests:

(1) *Organization.*—A special committee should be appointed to conduct the contest. Representatives of local business interests, extension and farmers' organizations, and the school system should be included in the committee personnel.

(2) *Duties.*—This committee in cooperation with the extension agent will:

(*a*) Outline the rules governing a contest.

(*b*) Procure funds for prizes.

(*c*) Win active support of school, business, and rural organizations.

(*d*) Conduct contest.

(*e*) Judge slogans and make awards.

(3) *Rules.*—The rules governing a contest should be simple but explicit with reference to eligibility and proper entry of contestants. A time limit of two to four weeks is advisable. In most contests it is also advisable to limit the number of letters and words included in slogans submitted. Rules applied in a Maine contest are given below as an example.

Eligibility: Any member of the county extension organization or of a boys' and girls' club may compete.

Length: Limited to 23 letters and spaces between words.

Time limit: No entry accepted after October 10.

Awards: First prize, $25; second prize, $15; third prize, $10.

Scoring: Appeal, 50 points; adaptability to campaign, 25 points; simplicity, 15 points; originality, 10 points.

(4) *Conduct.*—Full information should be given out several weeks before a contest begins. This should cover:

(*a*) Purpose of slogan contest.

(*b*) Reasons for carrying on particular project.

(*c*) Facts about practices recommended.

(*d*) Personnel of groups supporting contest.

This should be followed during the contest with consistent publicity. The whole process may be expedited also, if instructions, rules, facts about the practice, and suggested slogans, together with suitable entry blanks are furnished school children and other prospective competitors.

(5) *Awards.*—Cash awards are best, and usually three to five prizes will suffice. Often a first prize not exceeding $10 is ample.

(6) *Use.*—Upon the close of the slogan contest the effort must be directed to make full use of the winning slogans. The following uses are suggested:

(*a*) As footnote on all stationery.

(*b*) Top of first page on issues of the local extension news.

(*c*) On all circular letters and post cards.

(*d*) As a heading or footnote for all news notes and articles referring to the project.

(*e*) As lead on all posters.

(*f*) In the form of banners or signs on all exhibits and displays.

(*g*) Large stickers for automobiles.
(*h*) Rubber stamp on any circulars or bulletins sent out.
(*i*) On small stickers for envelopes for use by business men.
(*j*) On tags to be placed on "empties" (milk cans, baskets, shipping crates), or bags of feed purchased.

Demonstrations

There are two general types of demonstration, viz, method demonstrations and comparative-result demonstrations. Both types are concerned with demonstrating established facts. Both are used to show the local application of a recommended practice.

Method.—Method demonstrations are used to illustrate, to local groups of people, the methods or operations involved in certain practices, such as culling flocks, judging livestock, treating seeds, grading and packing fruits, and fitting a garment. Many of such demonstrations may be used to give interested persons opportunity to practice what is being taught. Method demonstrations may be developed into result demonstrations, but generally they are used to illustrate a talk or lecture on some better practice. They are most effective when supplemented by diagrams, photographs, charts, and other visual aids, and reenforced with printed directions which are distributed to those present.

Following is an outline of the principal steps which need to be considered in the planning of effective method demonstrations:
(1) Statement of need for demonstrations.
(2) Plan of demonstrations.
(3) Number to be used and where best conducted.
(4) Program of demonstration meeting.
(5) Planning arrangements for demonstration meeting.
(6) Conducting the meeting.
(7) Procuring adoption of practice.
(8) Information service.

Result.—Comparative result demonstrations are used to compare the methods and results of a recommended practice with the methods and results of the prevailing practice. Both practices are conducted under the same conditions, one being used as a check against the other. The recommended practice must prove its practical worth, locally. Therefore, comparative-result demonstrations are used publicly as proofs and examples. They need, however, to be reenforced by tours, meetings, exhibits, posters, news notes, and other suitable means and agencies. Then such demonstrations will be most effective in teaching the value of recommended practices and in influencing people to adopt them.

In the making of plans for effective use of comparative-result demonstrations the following steps or operations need to be worked out:
(1) Statement of need for demonstrations.
(2) Plan of demonstrations—type; size; checks.
(3) Number to be used and where best located.
(4) Selecting demonstrators.
(5) Instructing demonstrators.
(6) Procuring supplies and laying out demonstrations.
(7) Supervising demonstrations.
(8) Using field meetings and other means in connection with demonstrations.
(9) Measuring results and obtaining records.
(10) Using results.
(11) Information service throughout the year.
(12) Planning for next year.

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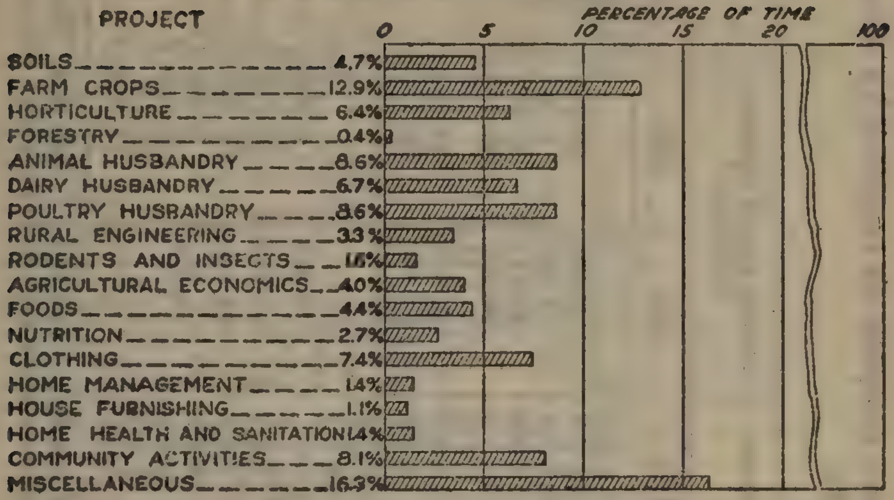
MEASURING RESULTS

Accomplishments



Percentage of agents' and specialists' time devoted to projects in 1924. (Only field work of specialists as reported by county extension agents is included)

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Adult and junior demonstrations completed and improved practices adopted as reported by all county extension agents, 1923 and 1924

Item	Adult result demonstrations		Junior result demonstrations[1]		Better practices adopted	
	1923	1924	1923	1924	1923	1924
Soils	34, 550	38, 589			323, 009	262, 351
Cereals	31, 286	33, 664	18, 961	20, 315	374, 809	197, 434
Legumes and forage	66, 261	68, 516	4, 325	4, 583	312, 745	218, 026
Potatoes, cotton, and other special crops	29, 359	32, 880	14, 647	21, 889	311, 864	187, 246
Horticulture	97, 266	70, 510	60, 407	56, 152	369, 991	240, 949
Forestry	1, 422	1, 719	43	218	4, 635	5, 628
Dairy	21, 107	18, 816	10, 473	14, 459	315, 569	375, 492
Animal husbandry	11, 263	12, 793	34, 409	30, 171	240, 956	185, 214
Poultry	65, 359	41, 511	50, 048	51, 039	309, 719	233, 691
Rural engineering	11, 115	17, 468			110, 084	114, 487
Rodents and insects	28, 168	26, 527			173, 376	181, 221
Agricultural economics			6, 018	5, 985	1, 098, 363	649, 291
Foods	176, 094	118, 682	107, 513	94, 899	888, 431	283, 273
Nutrition		28, 118		29, 812		124, 317
Clothing	87, 254	75, 586	94, 560	100, 887	383, 592	292, 131
Home management	27, 541	18, 625	15, 429	8, 431	93, 073	59, 020
House furnishings		19, 062		10, 519		62, 067
Home health and sanitation	16, 075	13, 972		24, 534	112, 463	128, 767
Miscellaneous	17, 328	8, 450	11, 913	15, 369	39, 847	43, 176
Total	721, 448	645, 488	428, 746	489, 262	5, 462, 526	3, 843, 781

[1] Boys' and girls' club members completing their demonstrations.

Enrollment in boys' and girls' clubs, by major projects, 1915–1924

Project	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924
Corn	55, 212	54, 263	53, 944	61, 278	7, 345	35, 676	34, 891	33, 130	35, 317	31, 251
Potato	11, 796	10, 754	18, 825	28, 516	10, 790	13, 845	14, 773	14, 589	14, 427	17, 545
Garden	123, 884	108, 439	223, 936	364, 778	215, 059	108, 971	77, 994	71, 168	62, 606	88, 916
Cotton	1, 286	3, 134	5, 297	9, 668	(1)	6, 674	2, 840	4, 116	8, 830	17, 142
Dairy cattle			2, 968	8, 994	6, 350	11, 307	8, 709	10, 845	15, 381	22, 197
Beef cattle	1, 198	2, 318	1, 125	2, 469	2, 213	5, 436	4, 954	5, 628	6, 139	7, 014
Sheep				4, 876	2, 988	3, 605	2, 393	1, 842	2, 204	3, 353
Swine	7, 355	31. 240	46, 858	102, 972	23, 623	60, 191	56, 847	59, 687	51, 611	38, 320
Poultry	23, 852	22, 632	37, 218	84, 615	73, 816	68, 682	72, 210	79, 573	90, 115	90, 462
Food preservation	59, 147	58, 218	136, 396	83, 951	32, 656	23, 832	64, 013	78, 084	81, 960	84, 145
Food preparation	6, 504	9. 105	25, 933	3, 987	11, 540	9, 579	13, 781	11, 472	55, 918	103, 653
Bread	10, 992	14, 026	16, 753	18, 583	8, 789	8, 470	9, 904	35, 974	38, 338	
Clothing	10, 074	16, 942	23, 637	38, 239	31, 419	29, 228	99, 897	123, 599	148, 407	174, 002
Other clubs	6, 301	2, 523	69, 571	205, 944	209, 210	51, 302	74, 814	71, 250	111, 255	267, 663
Total	317, 601	333, 594	662, 461	1, 018, 870	635, 798	436, 798	538, 020	600, 957	722, 508	945, 663

[1] No project distribution of 158,738 enrollment by county agents in South available.

Different Boys and Girls in Clubs, 1923 and 1924

Since 1923 data have been compiled regarding the number of different boys and girls carrying on club work in order to avoid counting the same boys and girls more than once if enrolled in two or more projects. The total enrollment of different boys and girls in 1924 was 510,355 as compared to 459,074 in 1923; 209,810 boys and 300,545 girls were enrolled in 1924 as compared to 187,277 boys and 271,797 girls in 1923. The total number of different boys and girls completing their work was 283,283 in 1924 as compared to 249.416 in 1923; 116,947 boys and 166,336 girls completed the work outlined in 1924 as compared to 99,222 boys and 150,194 girls in 1923.

Effectiveness of Extension

On approximately three out of every four farms the farmer or the home maker has been influenced by extension teaching to adopt one or more of the improved practices advocated. This statement is based on information obtained through personal interviews, by representatives of the Federal and State extension services, with farmer and home maker on 3,954 farms in representative communities in the States of Iowa, New York, Colorado, and California during 1923 and 1924.

Farms and homes reporting the adoption of new or better practices

Item	Number	Per cent	Average
Farm and home records obtained	3,954	100	
Farms reporting some changed practices	2,912	74	
Practices changed	9,833		3.4
Farms reporting agricultural practices changed	2,687	68	
Agricultural practices changed	6,979		2.6
Homes reporting home-economics practices changed	1,285	32	
Home-economics practices changed	2,854		2.2

In the three States of New York, Colorado, and California information was obtained regarding the means and agencies employed in extension which had in any way helped to bring about the adoption of these better farm and home practices. In the next table the methods responsible for changed practices are listed in order of the frequency with which they were reported.

Relative frequency with which extension methods were reported

Method responsible	Number of practices affected	Percentage of all practices
Adult demonstration	3,480	42.0
Meetings	3,431	41.4
Indirect	2,159	26.0
News service	904	10.9
Bulletin	833	10.0
Farm visit	813	9.8
Office call	434	5.2
Junior demonstration	198	2.4
Extension schools	154	1.9
Correspondence	123	1.5
Leader training	115	1.4
Circular letters	110	1.3
Telephone	35	.4
Study courses	26	.3

The close relationship between attendance at meetings, inspection of demonstrations, and participation in other extension activities is brought out by study of the data for the same farms in the States of Iowa, New York, Colorado, and California.

Participation in extension activities as bearing on farms changing practices

Group	Number of farms	Percentage of all farms	Percentage of farms changing practices			Average number of practices changed
			Agricultural	Home economics	Any	
Farms having extension activities on farm or in home	586	15	94	67	98	5.4
Other farms participating in extension activities	1,773	45	79	37	86	3.2
Farms not participating in extension activities	1,595	40	46	14	51	2.3

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Where extension activities had been conducted on the farm or in the home the adoption of improved practices was reported in 98 per cent of the replies. Of the farmers and home makers attending activities on neighboring farms or at community centers, 86 per cent changed some practices. It is interesting to note in this connection that fully one-half of the farms not represented at a single extension activity had benefited from extension through the adoption of the better practices advocated. The farms represented at extension meetings and other activities were also reached more intensively than the farms not so represented.

The attitude of farming people toward the extension service was recorded for three of the States (New York, Colorado, and California) studied. The results indicate that the extension activities have now been accepted by a substantial majority of the rural people.

Attitude toward extension work as indicated by opinions expressed by farmers

Group	Number of farms	Percentage
Farm records obtained	3,405	100
Reported favorable	2,246	66
Reported indifferent	812	24
Reported opposed	151	4
No attitude reported	196	6

SERVICES AVAILABLE

Federal Extension Service

The Federal Extension Service is the agency through which the various bureaus of the department conduct their extension activities. It represents the Secretary of Agriculture in his relations to all extension work conducted by the State colleges of agriculture under the terms of the Federal cooperative agricultural extension act, commonly known as the Smith-Lever Act, or which may be conducted under the terms of the general memorandum of understanding entered into by the Secretary of Agriculture with the States. Under the terms of this general agreement the Secretary of Agriculture has agreed that if each State will create an extension division and place all its extension work in it with a director in charge, chosen by the college of agriculture but acceptable to the Federal Department of Agriculture, the department will conduct all the extension work which it is authorized by Congress to do in the State, in the same organization and have it administered by the same director.

The Extension Service at Washington, D. C., is made up essentially of five offices, namely, (1) Office of Cooperative Extension Work, (2) Office of Exhibits, (3) Office of Motion Pictures, (4) Office of Demonstrations on Reclamation Projects, and (5) Office of Agricultural Instruction.

Office of Cooperative Extension Work

The Office of Cooperative Extension Work, with a staff of 10 administrative and supervisory officers, 12 organization field agents, 10 subject-matter field agents, and a clerical force of approximately 80 is charged, through the Director of Extension Work, with the administration of funds given to the department for the purpose of cooperation with the States in the employment of county agents, home demonstration agents, boys' and girls' club agents, and farm-management demonstrators. Assistance is given the State in the planning and organizing of extension work. Studies of extension methods are also made in the States in order to get results that will benefit the country as a whole. The small staff of Federal extension specialists serves to carry information from the subject-matter bureaus of the department to the extension specialists of the subject-matter departments of the States, and through them to the county extension forces. It is also the office of the department which administers funds provided for under the Smith-Lever Act for cooperative extension work in the States. County extension agents are nearly all paid in part from county funds, Smith-Lever funds, and Federal Department of Agriculture funds. Those extension agents who receive any part of their salaries from Department of Agriculture funds are Federal agents. They represent the Department of Agriculture in the communities and counties in which they work in carrying to farmers and their families such matter as the department has ready for extension.

In carrying on cooperative extension work under the provisions of the Smith-Lever Act the land-grant colleges are required by law to submit their plans of work to the Federal Department of Agriculture at the beginning of each fiscal year for consideration and approval for the expenditure of funds which they receive from the Federal Government and the State offset thereto. These plans usually are drawn up so as to extend the work of

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both the State colleges of agriculture and the Federal Department of Agriculture. The responsibility for carrying out the plans of work thus agreed upon rests with the extension director in each State. Officials from the Federal Department of Agriculture examine the accounts of the institution each year in regard to Smith-Lever funds to see that all the moneys have been expended in accordance with the law and general agreement, and visit and otherwise keep in touch with the actual work in the field. Each State extension director makes an annual report on the extension work of his State, copies of which are filed with the Secretary of Agriculture and the Federal Secretary of the Treasury. All county extension agents who receive any portion of their salary from the Federal Department of Agriculture make an annual report to the Federal Secretary of Agriculture through the State extension service and the Office of Cooperative Extension Work.

The Office of Cooperative Extension Work cooperates with the State extension services in studying extension research problems in order to build up a fund of data that will enable extension workers to increase their effectiveness. Field studies relating to the effectiveness of extension in reaching rural people, junior extension work, alfalfa extension, and local leadership have been made during 1923, 1924, and 1925 in the following States: Iowa, New York, Colorado, California, Massachusetts, New Jersey, Georgia, Wisconsin, Arkansas, and South Dakota.

Monographs.—In addition to compiling the statistical results of cooperative extension work in the 48 States, the office prepares mimeographed excerpts from the narrative reports, which are now available, covering about 30 subjects. The subjects covered in these digests include better-sire campaigns, ton-litter contests, community buildings, cotton insect control, cotton fertilizers, potato spray rings, soy beans, weeds, home water supply and hydroelectric power plants, cooperative fruit marketing, crop rotation, forestry, and various phases of the poultry and dairy industries, as well as many others.

Foreign Digests.—Twice a year mimeographed digests of extension activities in other countries throughout the world are prepared for distribution to State extension workers.

Office Systems.—Upon request assistance is rendered the States in installing a satisfactory system of records in the county extension offices. Department Circular 107, entitled "A System of Field and Office Records for County Extension Workers," is available for distribution in this connection.

The Office of Cooperative Extension Work cooperates with the State extension services in maintaining a service on visual instruction and publications that is available to all States.

Visual Instruction—*Lecture demonstrations.*—Provides personnel to give at field conferences illustrated talks on the preparation and use of photographs, lantern slides, charts, and other illustrative material.

Circulars.—Supplies mimeographed circulars on the following subjects: Photographic pointers, selection and use of lantern slides, preparation of charts, chart-making equipment and materials, classification of photographs of agricultural subjects, and selected list of references on the preparation and use of illustrations.

Correspondence.—Answers inquiries from extension workers regarding methods of visual instruction and the

preparation and use of photographs, lantern slides, charts, and other illustrative material used in extension work.

Publications—*Distribution.*—Arranges with the department office of information for supplying copies of available department publications requested by extension workers through State extension divisions.

News Service.—Prepares or arranges with the department press service for the preparation of news statements regarding developments, methods, and results in national and regional extension work, which include matter for publication in the department Official Record, Clip Sheet, and mimeographed release, and as special contributions to individual magazines and journals.

Photographs—*Field photographs.*—Provides personnel to take field photographs of extension work in cooperation with the States for the purpose of illustrating department and State publications and news material and for lantern-slide and exhibit use.

Photographic reference file.—Maintains a photographic reference file of 20,000 photographs on a wide variety of agricultural and home-economics subjects, making readily accessible to extension workers consulting the file the best available department photographs on any given subject.

Supplying photographs at cost.—Arranges with the department office of information for supplying at cost prints of available department photographs on agricultural and home-economics subjects for illustrating State publications and news material, and for lantern slide and exhibit use.

Educational photographic panels.—Prepares at cost educational photographic panels from either department or State photographs on selected subjects that may be requested by State extension divisions.

Classifying photographs.—Supplies information regarding classification and filing of photographs and organization of a photographic reference file.

Photographic equipment.—Answers requests for information regarding suitable photographic equipment for use in extension work.

Lantern Slides—*Production.*—Prepares lantern-slide series on various agricultural and home-economics subjects, in cooperation with subject-matter bureaus of the department, for distribution to extension workers.

Distribution.—Distributes for the use of extension workers, upon request of State extension divisions, lantern slides on various subjects prepared in cooperation with the subject-matter bureaus.

Supplying lantern slides at cost.—Arranges with the department office of information for supplying at cost lantern slides of available department photographs on agricultural and home-economics subjects for the use of extension workers upon request from State extension divisions.

Lantern-slide equipment.—Answers requests for information from extension workers regarding suitable equipment for lantern-slide production and projection, the coloring of lantern slides, and effective use of lantern slides in extension work.

Other Illustrative Material.—Illustrations for publications: Prepares on request special illustrations, sketches, and diagrams for department and State extension publications.

Educational posters.—Prepares upon request suggestive sketches for educational posters for use in extension campaigns and teaching.

Illustrative equipment.—Answers correspondence relative to suitable materials and equipment for making charts and preparing other illustrative material.

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Office of Exhibits

The Office of Exhibits is one of five units constituting the Extension Service. Its work has to do with the planning, designing, production, distribution, exhibition, and demonstration of a wide variety of agricultural exhibits based on the experimental, investigational, and research work of the United States Department of Agriculture. This involves a study of subject-matter, designs, principles, practices, materials, methods of operation, effects of heat, light, and motion, and other factors which play an important part in the production of attractive educational exhibits such as will prove of benefit and service to the public.

Careful studies are made of space arrangements, shipping facilities, and proper crating and packing to assure safety and economy of operation. Methods of presentation, contact, and demonstration are also studied in order to obtain the most effective means of visualization and at the same time to provide adequate information when the exhibit is not self-explanatory.

Experiments.—In addition to such studies the Office of Exhibits, in its effort to be of greatest service in dispensing department information through this form of visual presentation, conducts many experimental tests with mechanical devices, color processes, and various types of background settings in an effort to give more life and reality to the subjects presented and thus to create a greater interest in them.

Represents Entire Department.—The office of exhibits serves the entire department and is charged with the duty of correlating the information or subject matter furnished by the various bureaus and divisions and so portraying it in exhibit form as to tell a persuasive and convincing story.

Exhibits only for State, Interstate, and International Fairs.—The annual appropriation made by Congress to the office of exhibits provides only for exhibition at State, interstate, and international fairs. This makes it necessary to decline many applications for exhibits at county and rural fairs as well as requests for material for use on agricultural demonstration trains, at State colleges in connection with farmers' weeks, and at other similar gatherings and for special lectures and meetings in cities and rural communities. All exhibits built are, therefore, of such design and construction as will best serve the purpose at State fairs and expositions and that can be packed and shipped from one point of the country to another at a minimum of expense that the greatest number possible may obtain benefit from them.

Subject Matter.—The subject matter of the exhibits is furnished largely by the bureaus of the department and therefore covers a wide range of information on agriculture and allied subjects. In general these subjects are crop production, livestock raising, dairying, marketing, farm management, entomology, soils, forestry, roads, home economics, chemistry, weather, and boys' and girls' club work.

Purpose.—The exhibits are educational in character, and their purpose is to present useful and timely information on agricultural principles and practices. Some of the exhibits might be regarded as persuasive in character in that they seek to move the observer to carry out some desirable practice.

Presentation.—The information in the exhibits is presented in a variety of ways, ranging from a simple combination of illustrations and text to large displays in-

volving combinations of cut-out figures, models, objects, live animals, motion, light, and sound. Every effort is made to present the subject matter clearly, forcefully, and in a manner which interests the people who are to be benefited. The exhibits are so constructed that they may be set up or dismantled in a short time and may be packed easily for shipment.

Shipments and Exhibitions.—The major portion of the department's exhibits are circuited among fairs. They are usually sent out in carload lots divided into exhibition units occupying from 1,000 to 5,000 square feet of floor space. The circuit itineraries are based on applications for exhibits received from fair associations or other responsible organizations, which are asked to cooperate to the extent of furnishing space and transportation, installation, and maintenance expense without cost to the Department of Agriculture. The cost of railroad transportation is prorated among those sharing in the program, and cooperators deposit the amount with the disbursing officer of the department, making shipments possible on Government bills of lading at lowest possible rates.

Members of the department personnel accompany the exhibition units and superintend their installation, presentation, and shipment.

Variety of Subjects.—Since circuits necessarily must cover a very wide territory, with divergent agricultural problems, exhibits are included which have wide general application. Further, each exhibition unit may include only a single subject or it may cover many different subjects, such as dairying, human nutrition, club work, forestry, marketing, fire protection, livestock management, sanitation, highways, and crops. Among them usually are several subjects of particular application in the region shown.

Information and Publicity Material Furnished.—Photographs and descriptions of exhibits and summaries of subject matter covered by them are furnished for publicity purposes to fairs and to others interested. News items are released from time to time. Department informational material is distributed upon request at the exhibitions.

Assistance and Cooperation.—As the funds provided by Congress limit exhibit activities to State, interstate, and international fairs, the Office of Exhibits is unable to provide exhibits for college or county-agent work, farmers' meetings, and similar gatherings. It realizes, however, that many excellent opportunities come from this source, and so far as possible is glad to offer assistance and cooperation.

At the exhibit offices in Washington one or more exhibits usually are in the course of preparation at all times, and anyone interested in such work who desires to pay a personal call for the purpose of obtaining helpful ideas and information will be given every assistance possible.

Office of Motion Pictures

Extension workers interested in the use of educational motion pictures will find that the United States Department of Agriculture has prepared and is circulating films on more than 200 subjects.

These films deal with important topics in connection with beef cattle, dairy cattle, dairy products, diseases of cattle, parasites of cattle, horses, sheep raising, hog raising, diseases and parasites of hogs, poultry production, protection of wild game and birds, destructive rodents, cereal production, control of cereal insects, cotton

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production, cotton-insect control, fruit production, fruit diseases and insects, truck and other crops, home gardening, farm engineering, road building, forest road construction, food and other inspection services, forest-fire prevention, forest insects, forest pests and diseases, lumbering, scenery and recreation in the national forests, reforestation, bees, marketing of farm products, rural organization and extension work, and other phases of the work of the department and the cooperating State institutions.

How Films Are Distributed.—The films are distributed largely from the Office of Motion Pictures, Extension Service, United States Department of Agriculture, Washington, D. C., to which inquiries may be addressed. Many of the State agricultural extension divisions have purchased copies of the department films and are circulating them in their territories. The department favors this latter form of distribution in the interest of economy and efficiency, and is glad to authorize the purchase of prints of any of its films at the manufacturing charge and under certain conditions.

A complete list of the department's films, with information on the manner of distributing them, is given in Miscellaneous Circular 27, with supplement, which may be obtained on application. New lists are issued from time to time, and new films also are announced through the Official Record and other publications. No charge is made for the use of the films except the cost of transportation, which borrowers are required to pay both ways.

The films are used in a great variety of places, including meetings of local farmers' organizations, community meetings, colleges and schools, churches, clubs and lodges, commercial organizations, fairs and other expositions, and theaters. Another important use is in outdoor meetings, at which films are shown from traveling trucks equipped with electrical generating apparatus and projecting machines. It is estimated that in a year's time the department's films are shown to approximately 10,000,000 people.

Production of New Films.—The department has been producing from 25 to 30 new films each year. The program for film production is made up annually after the receipt of suggestions from State extension directors, bureaus of the department, and others. Extension workers desiring to advocate the production of new films on certain topics should send their suggestions to their State directors of extension for transmission to the department.

General requirements governing the making of new films are that scenarios must be prepared and approved in advance; that the films must be of a nontechnical nature and suitable for wide public use; that they must be of general rather than local application; and that the subject must be of importance sufficient to justify the expense of producing the film.

The department has its own scenario writers, directors, and photographers, and maintains a completely equipped motion-picture laboratory. Extension workers visiting Washington are invited to spend some time in the laboratory and, if possible, to see some of the films on the screen.

The Office of Motion Pictures is glad to furnish to extension workers any available information that may be requested on motion-picture projectors and other equipment and ways of using films.

2. AGRICULTURAL ECONOMICS

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  .02 Crop estimates.
    .021 Intentions to plant.
    .022 Crop acreage.
    .023 Crop condition.
    .024 Crop production.
    .029 Miscellaneous.
  .03 Livestock estimates.
    .031 Monthly livestock change.
    .032 Seasonal livestock supply.
    .039 Miscellaneous.
  .04 Grades and standards.
    .041 Crops.
    .042 Livestock.
    .049 Miscellaneous.
  .05 Inspection service.
    .051 Grain.
    .052 Hay.
    .053 Fruits and vegetables.
    .054 Butter and cheese.
    .055 Eggs.
    .056 Cotton classing.
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    .059 Miscellaneous.
  .06 Crop and market news service.
    .061 Daily market reports.
    .062 Weekly market review.
    .063 Monthly market review.
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    .065 Foreign crops and markets.
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  .09 Miscellaneous.
.1 Statistics.
  .10 General.
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    .110 General.
    .111 Domestic.
    .112 Foreign.
    .119 Miscellaneous.
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    .120 General.
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    .130 General.
    .131 Shipments.
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    .140 General.
    .141 Shipments.
    .142 Slaughter.
    .143 Cold-storage holdings of meat.
    .149 Miscellaneous.
  .15 Prices.
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.21 Field crops.
.210 General.
.211 Alkaloidal crops.
.212 Cereals.
.213 Fiber and textile crops.
.214 Forage crops.
.215 Oil crops.
.216 Sugar and sirup crops.
.217 Drug and medicinal crops.
.219 Miscellaneous.
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.220 General.
.221 Pome fruits.
.222 Stone fruits.
.223 Small fruits.
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.225 Subtropical fruits.
.229 Miscellaneous
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.24 Vegetables.
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.241 Root and tuber crops.
.242 Bulbous crops.
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.244 Cabbage crops.
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.247 Other annual crops.
.248 Perennial crops.
.249 Miscellaneous.
.25 Ornamentals.
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.262 Asses and mules.
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.264 Hogs.
.265 Sheep.
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.273 Poultry products.
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.276 Packing-house by-products.
.279 Miscellaneous.
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    - .3413 Production standards.
    - .3419 Miscellaneous.
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AGRICULTURAL ECONOMICS

GENERAL

Crop and Livestock Reporting Service

The crop and livestock reporting service furnishes information covering every important crop grown in the United States and all classes of livestock. Crop data are gathered with respect to intentions to plant, acreage planted, probable outturn, final yield, quality, total production, and stocks on hand. Livestock-reporting work covers many phases of production and the source of supplies of various markets. This information is distributed chiefly through:

(1) Press and radio releases from Washington and from 39 field offices.

(2) Monthly "Crops and Markets."

County agents desiring to receive advance releases or the monthly supplement may do so by applying to the Bureau of Agricultural Economics, Washington, D. C., or to the agricultural statistician in their own State.

Crop and livestock reports are based on information obtained through the following channels:

(1) Agricultural statisticians and crop specialists, one or more in each State, who maintain a corps of voluntary crop correspondents ranging in number from 300 to 3,000. These statisticians gather first-hand crop data and figures from railroads, elevators, and other organizations relative to stocks and movements of various farm commodities.

(2) Voluntary crop correspondents, numbering about 300,000, who report directly to Washington on schedules sent them by the crop reporting board, and special reporters for such commodities as cotton, tobacco, truck crops, and livestock. About 8,000,000 schedules are sent out annually.

(3) Rural carriers make periodical farm surveys and collect data on crop acreages, the number of various kinds of livestock, and miscellaneous information on cards furnished from Washington. Nearly 3,000,000 schedules are used annually in these surveys.

A branch office, in charge of an agricultural statistician, is maintained in each State and usually cooperates with the State board of agriculture or with some department of the State agricultural college. These offices both gather and distribute timely information of value to county agents, farmers, and others.

Crop and livestock estimates obtained through the various channels are tabulated and analyzed in Washington. All available means of checking these estimates are employed. Ginning reports furnish one of the most important sources of information on cotton production, and information obtained from elevators, railroads, and mills furnishes a check on the production estimates for grain. Complete data as to railroad shipments of fruits and vegetables are gathered and analyzed. Practically all railroads report the monthly livestock loadings and unloadings by stations, and all important stockyards report monthly the State of origin of livestock shipments.

Forecasts of Outturn.—The forecasts of probable outturn which are made during the growing season of crops are

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based on a system of pars and normals, a normal being defined as a "full" crop and the par a mathematical calculation of what a 100 per cent crop means, based on the relation of average condition to average yield. For example, if on June 1 the average condition of 80 per cent has meant a final yield of 20 bushels of wheat, a 100 per cent, or par, for June 1 would be 25 bushels. Therefore, if for June 1 next a par, or 100 per cent, condition of 25 bushels has been calculated, based on records of previous years, and the average condition of the reports should be 60 per cent, this would indicate a probable yield of 15 bushels. A detailed description of the statistical methods used may be obtained from the United States Department of Agriculture, Washington, D. C., on application.

Intention-to-Plant Reports.—Intention-to-plant reports are issued in order to maintain or to bring about a better adjustment of production. Reports are obtained from many thousands of farmers prior to planting time as to the number of acres they expect to plant and acres harvested the previous year of each crop. These intention-to-plant reports, when properly used, tend to prevent the over-expansion of planting after a period of high prices, and vice versa, and in the long run should provide a valuable means of maintaining a proper balance for agriculture.

Similar information is obtained with respect to intentions to breed sows, the idea being to enable farmers to market more sows in the event there is evidence of intention to overproduce, or to breed more sows if there is a tendency toward underproduction. Dairying information of a similar nature is also being gathered.

Grades and Standards

Uniform grading through the use of recognized standards is essential to the efficient marketing of farm products. Properly graded products not only sell more readily and at better prices, but grading also eliminates the loss sustained by paying freight and other marketing costs on inferior products which ultimately will be sorted out and discarded.

Under the grain standards act, the cotton standards act, and the United States warehouse act official standards have been promulgated for shelled corn, oats, rye, and wheat; for American upland, sea island, and American Egyptian cotton; and for wool. Tentative and recommended grades for other farm products have been formulated. Following is a list of the agricultural commodities for which official, tentative, and recommended grades have been designated:

Grain.—Official standards for corn (shelled), wheat, oats, rye, barley, grain sorghums, feed oats, and mixed feed oats. Recommended grades for rough and milled rice.

Hay.—Official standards for timothy, clover, grass, alfalfa, alfalfa mixed, prairie, Johnson, Johnson mixed, and grass mixed hay.

Cotton.—Official standards for American upland and American Egyptian.

Tobacco.—Classification of all American types and grades for the most important types.

Fruits.—Tentative and recommended grades for apples (barreled), grapes (juice), grapes (table), grapes (bunched), grapes (packed), peaches, pears, prunes (fresh), citrus fruits, pineapples, and strawberries.

Vegetables.—Tentative and recommended grades for asparagus, beans (string), beets (bunched), cabbage, cauli-

flower, cantaloupes, celery (rough), carrots (bunched), cucumbers, onions (northern grown), peanuts (White, Spanish, farmers' stock), peanuts (White, Spanish, shelled), peppers (sweet), potatoes, sweet potatoes, tomatoes (fresh and cannery), tomatoes (cannery), turnips (bunched), watermelons, cabbage, lettuce, and spinach.

Livestock.—Market classes and grades for livestock cover cattle and calves, swine, and sheep and lambs. Each of these groups is divided into classes based in general on sex and condition. The cattle and calves group is divided into the following classes: Steers, heifers, cows, bulls, stags, and calves; the swine group into farrow, gilt, sow, boar, stag, and pig classes; and the sheep and lamb group into lamb, wether, ram, and ewe classes. In general these classes are further divided into subclasses designating the condition of the animal, and these subclasses still further divided into age-selection and weight-selection groups, and finally into various grades according to the quality, conformation, and finish of the individual.

Dressed meat.—Market classes and grades for beef, veal, lamb, mutton, pork, and miscellaneous meats. Grades for carcass beef were made official July 1, 1926.

Wool.—Official standards of the United States comprise seven grades covering the entire range of diameter of fiber from very fine to very coarse wool, as follows: (1) Fine, (2) one-half blood, (3) three-eighths blood, (4) one-fourth blood, (5) low one-fourth blood, (6) common, and (7) braid.

Poultry Products.—Tentative grades for sound, clean-shell eggs, sound dirty-shell eggs, and cracked-shell eggs. Also tentative grades for buying eggs from producers.

Inspection Service

Grain.—Licensed grain inspectors are located in all the principal grain markets and shipping points. When grain for which official standards have been fixed and established is shipped by grade in interstate or foreign commerce it shall be inspected and graded by an inspector licensed under the United States grain standards act. In interstate shipments of grain by grade between noninspection points shippers are required to state on invoices covering the grain that it has not been inspected by a licensed inspector, and to advise the consignees that such grain is subject to the dispute privilege under the grain standards act.

Hay.—Federal hay inspection is available in markets in the following places: Auburn and New York, N. Y.; Augusta, Me.; Birmingham, Ala.; Boston, Mass.; Chicago, Ill.; Cleveland, Ohio; College Park, Md.; Kansas City, Mo.; Madison, Wis.; Norfolk and Richmond, Va.; Philadelphia, Pa.; Raleigh, N. C.; Trenton, N. J.; and Washington, D. C.

Cotton.—All cotton intended for delivery on future contracts is classified by officials of the Department of Agriculture. All cotton stored in bonded warehouses must be classified according to official Government standards.

Fruits and Vegetables.—Food-product inspection is available in the markets named below and at places which can be reached conveniently from these cities. This service is open to shippers, receivers, railroads, and other interested parties. It is purely a service and in no sense a police organization. Its purpose is to provide an impartial and unbiased report in order to afford some basis on which disputants can settle their differences promptly and with fairness to both sides.

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Designated inspection markets

Atlanta:
1714 Citizens and Southern Bank Building.
Baltimore:
339 Customhouse.
Boston:
705 Appraisers' Stores Building.
Buffalo:
220 Federal Building.
Chicago:
139 North Clark Street.
Cincinnati:
21–24 Fruit Exchange Building.
Cleveland:
2403 East Ninth Street.
Columbus, Ohio:
Statehouse Annex.
Denver:
329 Capitol Building.
Detroit:
1931 Howard Street.
Fort Worth:
1915 Farmers & Mechanics Bank Building.
Harrisburg:
Capitol Building.
Houston:
406 Southern Pacific Building.
Indianapolis:
1101 City Trust Building.
Kansas City, Mo.:
212 Railway Exchange Building.
Los Angeles:
285 Wholesale Terminal Building.
Memphis:
3 County Courthouse.
Minneapolis.
Room 1, Federal Building.
Milwaukee:
423 Federal Building.
New Haven:
301 Federal Building.
New Orleans:
207 Post Office Building.
New York:
204 Franklin Street.
Norfolk:
314 Board of Trade Building.
Omaha:
435 Keeline Building.
Philadelphia:
308 Bourse Building.
Pittsburgh:
403 Andrews Building.
Portland, Oreg.:
112 Citizens Bank Building.
Sacramento:
State Department of Agriculture.
St. Louis:
413 Old Customhouse.
Salt Lake City:
304–306 State Capitol.
San Diego:
Post Office Box 112.
San Francisco:
65 Appraisers' Building.
Washington:
Bureau of Agricultural Economics.
Wilkes-Barre:
226 Miners' Bank Building.

Wool.—The use of official wool standards is compulsory for warehouses licensed for storing wool under the United States warehouse act.

Dairy Products.—Under the food products inspection act the inspection of butter and cheese for quality and condition is available in the markets of Boston, Chicago, New York, Philadelphia, San Francisco, and Washington.

Poultry Products.—Egg inspection is available in the markets of Chicago and New York.

Crop and Market News Service

The Bureau of Agricultural Economics conducts a general market news service on a large number of farm products. The service has been in effect since 1915. It is designed to keep before the producer, distributor, and consumer a picture of the movement of important crops from the farms, the supplies arriving in the principal consuming and distributing markets, and the prevailing wholesale prices where trading is done.

Organization.—To accomplish the purpose of the news service branch offices have been established in practically all the important market centers. Most of the

offices are maintained entirely by the Federal bureau, but a few are conducted in cooperation with State market news agencies.

The permanent branch field offices of the market news service are located in the following cities: Boston, New York, Philadelphia, Baltimore, Washington, Richmond, Raleigh, Atlanta, Jacksonville, Pittsburgh, Columbus, Ohio, Cincinnati, Chicago, Fond du Lac, St. Paul, Minneapolis, St. Louis, Kansas City, Mo., Omaha, Fort Worth, Austin, Denver, Salt Lake City, San Francisco, Los Angeles, and Portland, Oreg.

Temporary Field Stations.—In addition to these permanent offices a number of temporary market news field offices are operated for short lengths of time each year at the principal fruit and vegetable shipping points. These offices open when shipments to market begin and close when the bulk of the particular crop at that point is moved.

Leased Wires Used.—The bureau uses the fastest means of communication available to-day—telegraph and radio. The branch offices in the consuming and distributing markets are connected with leased telegraph lines operated by bureau telegraphers. These wires are busy from 8 to 12 hours a day in the exclusive transmission of information which is vital to intelligent and successful food distribution. About 7,800 miles of wire are in daily use.

Scope of the Reports.—Market news reports are issued on livestock, meats and wool, fruits and vegetables, and dairy and poultry products. Weekly reports and summaries cover grain, hay, feed, and peanuts. Semimonthly reports are issued on honey and seasonal reports on the marketing of seeds.

The information contained in the reports is from a great number of sources. The movement of crops by the railroads is reported by about 1,200 railroad agents on 474 different lines and involves 248,000 miles of road. Their reports are sent in daily by telegraph for the current reports and later by mail for statistical purposes. More than 9,000 agents make monthly reports on the car-lot forwardings of fruit and vegetables. This part of the service provides the background of crop production and movement information. In the markets the market news men get reports of arrivals and hold overs from the railroad and steamship agents. Their demand and price information is obtained from the buyers and dealers on the wholesale markets.

The current market reports are flashed over leased wires to all the offices, so that they are available at all points at practically the same time.

The weekly and other periodical reports and summaries consist of reviews of movements and price tendencies in the marketing of various crops.

Mimeographed Reports.—Every branch office and temporary field station mimeographs its reports and distributes them to a mailing list. These lists consist of the names of producers, shippers, dealers, transportation agents, and banks. Very few consumers have found use for the reports.

In addition to the mimeographed reports that are issued, the market news men use every facility at their command to distribute their reports.

The newspapers and the newspaper press services are supplied with regular reports. The telegraph companies use a great deal of the current marketing material in the conduct of their commercial news dispatch service. Within the last three years the use of radio broadcasting

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has become a most valuable method of quick distribution of the reports.

Broadcasting by Radio.—By utilizing radio as a means of disseminating crop and market information the bureau is taking advantage of the newest means of communication, which has possibilities surpassing all that have been used in the past. Radio makes it possible for all who wish the information which is broadcast to help themselves to it by merely providing suitable receiving sets. The advantages of broadcasting information by radio are (1) that the information can be intercepted and copied by means of suitable equipment at any point within certain limits, regardless of whether such a place is connected with the rest of the world by railroad, telegraph, or any other of the ordinary means of communication; and (2) that the transmission of news is instantaneous.

During the past two years the use of the radio as a means for broadcasting entertainment, news, crop and market reports, speeches, and music has developed so rapidly and has attracted such widespread interest that there were, on October 1, 1926, 579 commercial radio broadcasting stations within the territorial limits of the United States. About 200 of these stations broadcast information originating in the Department of Agriculture, including weather, crop, and market reports.

Publications.—In addition to its daily reports and other bulletins, the bureau publishes "Crops and Markets," a periodical which contains much current information, the crop and livestock estimates, and other statistical material.

STATISTICS

General

Farms and farm property, 1910, 1920, 1925

EXTENT AND VALUE OF FARM PROPERTY

Item	1910 census	1920 census	1925 census
Number of farms	6,361,502	6,448,343	6,371,617
Approximate land area ... acres	1,903,289,600	1,903,215,360	...
All land in farms ... do	878,798,325	955,883,715	924,889,380
Improved land ... do	478,451,750	503,073,007	...
Woodland ... do	190,865,553	167,730,794	67,600,238
Other unimproved land ... do	209,481,022	285,079,914	...
Total crops [1] ... do	311,293,382	365,348,000	391,466,482
Land area in farms ... per cent	46.2	50.2	...
Farm land improved ... do	54.4	52.6	...
Acreage per farm ... acres	138.1	148.2	145.2
Improved acreage per farm ... do	75.2	78.0	...
Value of farm property:			
Total value ... dollars	40,991,449,090	77,924,100,338	...
Land and buildings ... do	34,801,125,697	66,316,002,602	49,546,523,759
Land alone ... do	28,475,674,169	54,829,563,059	37,779,050,467
Buildings ... do	6,325,451,528	11,486,439,543	11,767,473,292
Implements and machinery ... do	1,265,149,783	3,594,772,928	...
Livestock ... do	4,925,173,783	8,013,324,808	...

[1] Harvested crop land in 1924 was 344,280.267 acres.

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Farms and farm property, 1910, 1920, 1925—Con.

EXTENT AND VALUE OF FARM PROPERTY—Con.

Item	Per farm	Per acre	Per farm	Per acre	Per farm	Per acre
Average value:						
All farm property do	6,444	46.64	12,084	81.52	-------	-------
Land and buildings do	5,471	39.60	10,284	69.38	7,776	53.57
Land alone do	4,476	32.40	8,503	57.36	-------	-------
Buildings do	994	7.20	1,781	12.02	-------	-------
Implements and machinery do	199	1.44	557	3.76	-------	-------
Livestock do	774	5.60	1,243	8.38	-------	-------

NUMBER OF FARMS, BY SIZE

Item	1910 census	1920 census	1925 census
Under 20 acres	839,166	796,535	------------
Under 3 acres	18,033	20,350	------------
3 to 9 acres	317,010	268,422	------------
10 to 19 acres	504,123	507,763	------------
20 to 49 acres	1,414,376	1,503,732	------------
50 to 99 acres	1,438,069	1,474,745	------------
100 to 174 acres	1,516,286	1,449,630	------------
175 to 499 acres	978,175	1,006,477	------------
175 to 259 acres	534,191	530,800	------------
260 to 499 acres	443,984	475,677	------------
500 to 999 acres	125,295	149,819	------------
1,000 acres and over	50,135	67,405	------------

NUMBER OF FARMS, BY TENURE

Owners	3,948,722	3,925,090	3,868,334
Owning entire farm	3,354,897	3,366,510	------------
Hiring additional land	593,825	558,580	------------
Managers	58,104	68,449	40,755
Tenants	2,354,676	2,454,804	2,462,528
Share tenants	1,399,923	1,678,812	------------
Share-cash tenants	128,466	127,822	------------
Cash tenants	712,294	585,005	------------
Unspecified	113,993	63,165	------------

Farm value of crops, livestock, and livestock products, calendar years 1922–1925 [1]

CROPS

[Million dollars—i. e., 000,000 omitted]

Product	1922	1923	1924	1925
Cereals:				
Barley	96	113	139	131
Corn	2,226	2,538	2,470	2,175
Grain sorghum	87	93	81	58
Oats	475	554	742	586
Rice	39	37	46	52
Rye	70	38	64	41
Wheat	856	743	1,102	991
Others	22	22	25	23
Cotton, lint and seed	1,286	1,657	1,766	1,656
Flax, fiber and seed	23	37	74	50
Fruits	665	642	614	657
Hay and forage	1,529	1,619	1,674	1,514
Legume seed, beans, peas, etc	142	172	153	149
Seeds for planting, clover, etc	49	46	29	26
Sugar and sirup crops (including no sugar except maple)	134	153	150	138
Tobacco	287	311	244	250
Vegetables, potatoes, sweet potatoes, others, and farm gardens	1,011	1,169	963	1,311
Woodland products	305	318	306	327
Other crops	128	139	130	136
Total crops	9,430	10,401	10,772	10,270

LIVESTOCK AND LIVESTOCK PRODUCTS

Product	1922	1923	1924	1925
Animals raised:				
Cattle	954	988	892	1,002
Horses	151	130	101	83
Mules	43	37	40	39
Sheep	126	145	150	176
Swine	1,235	1,133	1,053	1,408
Others	7	7	7	8
Bee products	12	12	12	12
Dairy products:				
Milk sold [2]	735	950	937	934
Milk consumed [2]	640	801	777	824
Cheese	1	1	1	1
Butter made	220	246	237	240
Cream sold [3]	62	90	71	89
Butterfat sold	331	415	394	470
Skim milk, buttermilk, and whey	107	149	169	190
Poultry products:				
Eggs produced	513	597	525	618
Poultry raised	405	441	443	499
Wool	66	87	89	98
Others	4	4	4	4
Total animal products	5,612	6,233	5,902	6,694

[1] Values are based on weighted prices for the crop year.
[2] Includes milk equivalent of cream for household use.
[3] For cream powder and ice cream.

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Crop Production

Wheat: World production, 1894–1925

[Thousand bushels—i. e., 000 omitted]

Year	Production as reported	Estimated world total	Production in principal producing countries				
			United States	Canada	Russia [1]	India	France
1894	2,357,727	2,515,616	516,485	--------	477,199	271,375	344,180
1895	2,276,811	2,440,445	569,456	--------	309,660	261,293	339,595
1896	2,328,627	2,468,629	544,193	--------	412,038	200,866	340,268
1897	2,112,010	2,233,593	610,254	--------	340,170	200,229	242,227
1898	2,867,948	3,012,350	772,163	--------	459,289	269,113	364,906
1899	2,643,177	2,773,061	636,051	--------	454,145	255,273	365,449
1900	2,478,739	2,633,405	602,708	--------	422,994	200,000	325,542
1901	2,701,163	2,900,167	788,638	--------	427,782	264,825	310,913
1902	2,913,652	3,117,721	724,808	--------	607,370	227,380	327,898
1903	3,111,340	3,272,810	663,923	--------	621,459	297,601	362,968
1904	3,006,388	3,144,436	596,911	--------	666,752	359,936	299,639
1905	3,130,443	3,309,345	726,819	--------	636,287	283,076	334,838
1906	3,253,930	3,493,206	756,775	--------	543,841	319,950	328,697
1907	3,012,480	3,189,191	637,981	--------	570,570	317,061	381,223
1908	3,077,785	3,171,263	644,656	112,434	627,698	228,689	316,684
1909	3,551,056	3,625,128	700,434	166,744	846,166	285,197	359,174
1910	3,477,180	3,575,891	635,121	132,049	836,242	359,647	252,963
1911	3,522,157	3,570,369	621,338	230,924	563,485	375,629	322,339
1912	3,782,788	3,857,488	730,267	224,159	801,497	370,515	334,333
1913	4,011,754	4,087,654	763,380	231,717	1,027,662	368,219	319,370
1914	3,588,988	3,625,388	891,017	161,280	[2] 827,756	312,368	282,689
1915	4,144,659	4,166,259	1,025,801	393,543	[2] 826,784	376,992	222,776
1916	2,515,591	3,288,291	636,318	262,781	--------	323,045	204,908
1917	2,426,838	3,133,838	636,655	233,743	--------	382,144	[3] 137,096
1918	2,774,877	3,147,677	921,438	189,075	--------	370,421	[3] 228,688
1919	2,668,701	2,997,051	967,979	193,260	--------	280,261	[3] 187,091
1920	2,892,988	3,033,438	833,027	263,189	[3] 267,141	377,888	[3] 236,929
1921	3,303,749	3,316,749	814,905	300,858	[3] 171,384	250,357	[3] 323,467
1922	3,397,648	3,386,000	867,598	399,786	[3] 202,368	366,987	[3] 243,315
1923	3,486,381	3,836,000	797,381	474,199	[3] 326,685	372,363	[3] 275,569
1924	3,048,679	3,481,000	862,627	262,097	[3] 381,727	360,640	[3] 282,335
1925	---------	[4] 4,01000,0	[4] 669,365	[4] 416,850	[3] 661,130	[4] 324,651	[3] 329,077

[1] Includes all Russian territory reporting for years named.
[2] Excludes Poland.
[3] New boundaries.
[4] Preliminary.

Rye: World production, 1899–1925

[Thousand bushels—i. e., 000 omitted]

Year	Production as reported	Estimated world totals (preliminary)	Selected countries			
			United States	Russian Empire [1]	Germany	France
1899	1, 595, 285	1, 607, 186	30, 334	911, 633	341, 547	67, 223
1900	1, 563, 841	1, 579, 937	30, 791	920, 134	336, 621	59, 397
1901	1, 412, 160	1, 431, 740	31, 103	754, 927	321, 346	58, 386
1902	1, 619, 875	1, 638, 557	35, 255	919, 019	373, 764	45, 660
1903	1, 653, 933	1, 665, 588	31, 990	911, 944	389, 919	58, 127
1904	1, 744, 033	1, 750, 938	31, 805	1, 008, 440	396, 071	52, 669
1905	1, 499, 862	1, 507, 134	35, 167	737, 443	378, 200	58, 586
1906	1, 429, 513	1, 440, 852	36, 559	667, 605	378, 945	50, 888
1907	1, 541, 662	1, 553, 063	35, 455	815, 086	384, 146	56, 462
1908	1, 597, 515	1, 605, 055	35, 768	790, 098	422, 688	51, 691
1909	1, 758, 609	1, 762, 744	35, 406	903, 622	446, 763	55, 689
1910	1, 676, 414	1, 680, 193	34, 897	875, 135	413, 802	43, 883
1911	1, 579, 536	1, 582, 591	33, 119	768, 650	427, 776	46, 749
1912	1, 898, 177	1, 900, 437	35, 664	1, 050, 837	456, 600	48, 746
1913	1, 889, 313	1, 892, 513	41, 381	1, 011, 316	481, 169	50, 055
1914	1, 618, 879	1, 624, 341	42, 779	[2] 869, 657	410, 478	43, 884
1915	1, 585, 620	1, 590, 294	54, 050	[2] 909, 943	360, 310	33, 148
1916	593, 750	1, 494, 975	48, 862	----------	351, 826	33, 351
1917	470, 433	1, 228, 503	62, 933	----------	[3] 275, 696	[3] 25, 669
1918	513, 509	1, 170, 187	91, 041	----------	[3] 262, 832	[3] 30, 100
1919	517, 015	1, 057, 894	75, 483	----------	[3] 240, 161	[3] 30, 577
1920	615, 305	970, 356	60, 490	[3] 317, 081	[3] 194, 255	[3] 34, 492
1921	1, 248, 879	1, 248, 950	61, 675	[3] 345, 423	[3] 267, 626	[3] 44, 392
1922	1, 423, 610	1, 326, 889	103, 362	[3] 480, 625	[3] 206, 033	[3] 38, 412
1923	918, 679	1, 863, 080	63, 077	[3] 734, 337	[3] 263, 037	[3] 36, 517
1924	743, 084	1, 422, 415	64, 038	[3] 679, 068	[3] 225, 573	40, 241
1925 [4]	----------	1, 836, 934	48, 696	[3] 820, 040	[3] 317, 418	44, 766

[1] Includes all Russian territory reporting for years named.
[2] Excludes Poland.
[3] New boundaries.
[4] Preliminary.

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Corn: World production, 1900–1925

[Thousand bushels—i. e., 000 omitted]

Calendar year	Production as reported	Estimated world totals (preliminary)	Three selected countries		
			United States	Italy	Argentina
1900	3, 145, 539	3, 445, 529	2, 505, 148	87, 969	98, 841
1901	2, 328, 687	2, 637, 787	1, 613, 528	100, 455	84, 018
1902	3, 274, 417	3, 552, 137	2, 619, 499	71, 028	148, 946
1903	3, 133, 418	3, 417, 243	2, 346, 897	88, 990	175, 187
1904	3, 066, 601	3, 339, 736	2, 528, 662	90, 545	140, 707
1905	3, 464, 564	3, 743, 794	2, 748, 949	97, 265	194, 910
1906	3, 703, 932	3, 980, 577	2, 897, 662	92, 904	71, 768
1907	3, 354, 363	3, 628, 813	2, 512, 065	88, 412	136, 055
1908	3, 266, 956	3, 705, 956	2, 544, 957	95, 845	177, 155
1909	3, 390, 685	3, 703, 585	2, 572, 336	99, 289	175, 187
1910	3, 709, 655	3, 951, 255	2, 886, 260	101, 722	27, 676
1911	3, 547, 596	3, 790, 396	2, 531, 488	93, 518	295, 849
1912	4, 220, 154	4, 329, 454	3, 124, 746	98, 668	196, 642
1913	3, 557, 132	3, 743, 632	2, 446, 988	108, 388	263, 135
1914	3, 939, 799	4, 041, 799	2, 672, 804	104, 967	325, 178
1915	3, 990, 557	4, 142, 557	2, 994, 793	121, 824	161, 133
1916	3, 176, 062	3, 475, 462	2, 566, 927	81, 547	58, 839
1917	3, 719, 215	4, 049, 715	3, 065, 233	82, 771	170, 660
1918	3, 279, 232	3, 469, 832	2, 502, 665	76, 590	224, 239
1919	3, 671, 630	3, 962, 630	2, 811, 302	85, 846	258, 686
1920	4, 292, 421	4, 437, 421	3, 208, 584	89, 298	230, 420
1921	4, 044, 444	4, 054, 444	3, 068, 569	92, 325	176, 171
1922	4, 027, 438	4, 109, 000	2, 906, 020	76, 830	176, 103
1923	4, 205, 958	4, 459, 000	3, 053, 557	89, 204	276, 756
1924	3, 128, 634	3, 815, 000	2, 312, 745	105, 679	186, 298
1925			[1] 2, 900, 581	106, 295	

[1] Preliminary.

Oats: World production, 1894–1925

[Thousand bushels—i. e., 000 omitted]

Year	Production as reported	Estimated world totals (preliminary)	Three selected countries		
			United States	Germany	France
1894	2,872,863	3,039,717	715,535	453,328	294,344
1895	3,026,778	3,213,431	885,959	430,205	305,742
1896	2,894,896	3,113,148	780,124	411,259	296,205
1897	2,680,919	2,889,281	791,442	393,979	253,257
1898	2,995,851	3,181,262	842,747	465,317	321,562
1899	3,333,003	3,620,889	925,555	474,174	307,914
1900	3,226,625	3,470,581	913,800	488,590	285,313
1901	2,810,028	2,960,683	778,392	485,711	254,900
1902	3,557,569	3,812,029	1,053,489	514,447	319,691
1903	3,326,743	3,621,951	869,350	542,427	344,329
1904	3,561,205	3,832,755	1,008,931	477,847	290,902
1905	3,474,967	3,752,142	1,090,236	451,013	305,736
1906	3,430,518	3,713,918	1,035,576	580,869	295,110
1907	3,526,136	3,775,336	805,108	630,318	352,712
1908	3,729,862	3,783,767	850,540	530,126	327,159
1909	4,530,467	4,546,147	1,068,289	628,712	383,139
1910	4,252,783	4,257,893	1,186,341	544,287	331,866
1911	3,964,808	3,978,991	922,298	530,764	349,247
1912	4,738,090	4,756,725	1,418,337	586,987	355,089
1913	4,781,258	4,798,558	1,121,768	669,231	357,049
1914	4,131,958	4,148,447	1,141,060	622,674	318,333
1915	4,513,559	4,581,429	1,549,030	412,400	238,551
1916	3,126,676	4,023,526	1,251,837	484,007	277,117
1917	3,122,116	3,882,136	1,592,740	[1] 249,964	[1] 220,336
1918	3,113,316	3,777,336	1,538,124	[1] 301,839	[1] 180,553
1919	2,772,076	3,283,092	1,184,030	[1] 309,587	[1] 179,823
1920	3,606,466	3,836,484	1,496,281	[1] 332,490	[1] 291,406
1921	3,457,790	3,457,805	1,078,341	[1] 344,812	[1] 244,455
1922	3,765,408	3,711,000	1,215,803	[1] 276,619	[1] 288,264
1923	3,802,337	4,352,000	1,305,883	[1] 420,731	[1] 336,944
1924	3,564,921	4,184,000	1,522,665	[1] 389,525	[1] 305,535
1925	------------	4,661,000	1,501,909	[1] 384,740	[1] 330,315

[1] New boundaries.

Division of Statistical and Historical Research. Official sources and International Institute of Agriculture unless otherwise stated.

U. S. D. A.—10-1-26

Rice: World production, 1900–1925 (in terms of cleaned rice)

[Thousand pounds—i. e., 000 omitted]

Year	Production as reported	Estimated world totals, exclusive of China	Production in the chief producing countries [1]		
			India	Japan	Java and Madura [2]
1900–1901	68, 456, 675		46, 312, 750	13, 026, 905	
1901–2	65, 363, 899		43, 040, 939	14, 738, 427	
1902–3	74, 174, 773		52, 582, 298	11, 602, 474	
1903–4	75, 548, 201		49, 199, 438	14, 599, 842	
1904–5	79, 117, 049		50, 227, 520	16, 157, 087	
1905–6	72, 528, 630		48, 511, 680	10, 421, 342	
1906–7	75, 988, 426		47, 906, 880	14, 546, 194	
1907–8	72, 523, 092		42, 598, 080	15, 409, 976	
1908–9	74, 895, 930		43, 877, 120	16, 315, 318	
1909–10	99, 328, 460	107, 000, 000	63, 869, 120	16, 473, 579	5, 723, 000
1910–11	99, 935, 172	106, 000, 000	64, 522, 320	14, 650, 132	5, 738, 000
1911–12	103, 527, 182	110, 000, 000	63, 943, 040	16, 245, 745	6, 170, 000
1912–13	109, 162, 633	109, 000, 000	63, 801, 920	15, 777, 677	5, 842, 000
1913–14	111, 686, 746	113, 000, 000	64, 554, 560	15, 789, 000	6, 440, 000
1914–15	114, 376, 495	113, 000, 000	61, 109, 440	17, 908, 918	6, 339, 000
1915–16	124, 876, 819	124, 000, 000	73, 315, 200	17, 569, 018	6, 431, 000
1916–17	129, 166, 272	129, 000, 000	78, 520, 960	18, 363, 000	6, 409, 000
1917–18	[3] 201, 777, 415	131, 000, 000	80, 637, 760	17, 142, 858	6, 742, 000
1918–19	106, 431, 570	105, 000, 000	54, 526, 080	17, 185, 000	6, 409, 000
1919–20	126, 278, 366	123, 000, 000	71, 742, 720	19, 106, 360	7, 435, 000
1920–21	[3] 170,217, 972	117, 000, 000	61, 962, 880	19, 858, 000	6, 250, 000
1921–22	127, 576, 151	127, 000, 000	74, 278, 000	17, 335, 796	5, 624, 000
1922–23	129, 816, 000	132, 000, 000	75, 524, 000	19, 067, 000	6, 864, 000
1923–24	107, 739, 000	118, 000, 000	63, 164, 000	17, 418, 000	6, 832, 000
1924–25		127, 000, 000	69, 440, 000	17, 961, 000	7, 076, 000
1925–26 [4]			68, 000, 000	18, 759, 000	

[1] China would rank among the three chief rice-producing countries, but owing to lack of official statistics has been omitted.
[2] Irrigated rice.
[3] Large increase due to the fact that an estimate was available for China, i. e., 52,788,000,000 pounds in 1920 and 70,218,667,000 in 1917.
[4] Preliminary.

The figures for each year include the crop harvested in the Northern Hemisphere within the calendar year, and the following harvest in the Southern Hemisphere.

Barley: World production, 1899–1925

[Thousand bushels—i. e., 000 omitted]

Year	Production as reported	Estimated world totals (preliminary)	Three selected countries		
			Russian Empire [1]	Germany	Japan
1899	973, 216	1, 143, 901	226, 909	137, 047	77, 309
1900	984, 210	1, 168, 630	236, 981	137, 888	82, 420
1901	1, 046, 723	1, 222, 624	239, 917	152, 535	83, 352
1902	1, 182, 478	1, 365, 344	338, 251	142, 391	74, 078
1903	1, 195, 298	1, 356, 104	357, 471	152, 652	59, 737
1904	1, 140, 319	1, 313, 769	346, 255	135, 408	80, 794
1905	1, 158, 453	1, 313, 903	346, 966	134, 203	77, 473
1906	1, 262, 809	1, 456, 706	330, 962	142, 900	83, 967
1907	1, 261, 256	1, 438, 416	377, 031	160, 649	90, 480
1908	1, 293, 613	1, 434, 561	402, 258	140, 538	87, 138
1909	1, 522, 309	1, 648, 697	501, 869	160, 551	87, 185
1910	1, 396, 972	1, 518, 917	487, 919	133, 330	81, 953
1911	1, 449, 535	1, 541, 983	436, 569	145, 133	86, 480
1912	1, 575, 130	1, 619, 575	496, 352	159, 924	90, 559
1913	1, 726, 095	1, 778, 842	600, 232	168, 709	101, 477
1914	1, 514, 983	1, 557, 233	[2] 432, 615	144, 125	85, 774
1915	1, 563, 397	1, 585, 154	[2] 429, 161	114, 077	94, 959
1916	1, 048, 089	1, 514, 614	----------	128, 450	89, 335
1917	982, 142	1, 434, 642	----------	[3] 89, 886	88, 896
1918	1, 128, 067	1, 488, 567	----------	[3] 93, 504	87, 769
1919	927, 303	1, 136, 303	----------	[3] 87, 741	89, 356
1920	1, 156, 526	1, 244, 526	[3,4] 183, 583	[3] 82, 344	84, 909
1921	1, 267, 713	1, 276, 713	[3,4] 100, 826	[3] 89, 056	82, 323
1922	1, 332, 002	1, 324, 000	[3,4] 115, 413	[3] 73, 824	81, 411
1923	1, 326, 790	1, 534, 000	[3,4] 211, 733	[3] 108, 446	68, 858
1924	964, 763	1, 382, 000	[3] 174, 765	[3] 110, 226	74, 982
1925 [5]	------------	1, 689, 000	[3] 274, 716	[3] 119, 373	80, 081

[1] Includes all Russian territory reporting for years named.
[2] Excludes Poland.
[3] New boundaries.
[4] Excluding Turkestan and Transcaucasia.
[5] Preliminary.

Division of Statistical and Historical Research. For each year are shown the production during the calendar year in the Northern Hemisphere, and the succeeding harvest in the Southern Hemisphere.

U. S. D. A.—10-1-26

Cotton: World production, 1900–1925

[Bales of 478 pounds net]

Year beginning August 1	Production as far as reported	Estimated world totals	Three principal producing countries		
			United States	India	Egypt [1]
	Bales	*Bales*	*Bales*	*Bales*	*Bales*
1900–1	14, 809, 578		10, 123, 027	2, 471, 000	1, 126, 000
1901–2	14, 226, 730		9, 509, 745	2, 297, 000	1, 320, 000
1902–3	16, 823, 334		10, 630, 945	2, 818, 000	1, 210, 000
1903–4	16, 185, 114		9, 851, 129	2, 645, 000	1, 349, 000
1904–5	20, 007, 125		13, 438, 012	3, 172, 000	1, 308, 000
1905–6	16, 856, 569		10, 575, 017	2, 859, 000	1, 235, 000
1906–7	21, 259, 290		13, 273, 809	4, 129, 000	1, 440, 000
1907–8	17, 357, 753		11, 107, 179	2, 613, 000	1, 499, 000
1908–9	21, 144, 006		13, 241, 799	3, 090, 000	1, 399, 000
1909–10	19, 289, 657		10, 004, 949	3, 998, 000	1, 036, 000
1910–11	21, 873, 607		11, 608, 616	3, 254, 000	1, 555, 000
1911–12	25, 322, 333		15, 692, 701	2, 730, 000	1, 530, 000
1912–13	24, 994, 921		13, 703, 421	3, 702, 000	1, 554, 000
1913–14	26, 214, 631		14, 156, 486	4, 239, 000	1, 588, 000
1914–15	28, 556, 341		16, 134, 930	4, 359, 000	1, 337, 000
1915–16	17, 605, 635		11, 191, 820	3, 128, 000	989, 000
1916–17	19, 768, 309	19, 905, 000	11, 449, 930	3, 759, 000	1, 048, 000
1917–18	19, 598, 564	19, 747, 000	11, 302, 375	3, 393, 000	1, 304, 000
1918–19	20, 556, 648	20, 678, 000	12, 040, 532	3, 328, 000	999, 000
1919–20	21, 319, 924	21, 331, 000	11, 420, 763	4, 853, 000	1, 155, 000
1920–21	20, 795, 387	20, 984, 000	13, 439, 603	3, 013, 000	1, 251, 000
1921–22	15, 265, 137	15, 439, 000	7, 953, 641	3, 753, 000	902, 000
1922–23	18, 560, 030	19, 300, 000	9, 762, 069	4, 247, 000	1, 391, 000
1923–24	19, 062, 239	19, 600, 000	10, 139, 671	4, 320, 000	1, 353, 000
1924–25	22, 211, 000	24, 800, 000	13, 627, 936	5, 069, 000	1, 507, 000
1925–26 [2]			15, 603, 000	5, 064, 000	1, 629, 000

[1] China exceeds Egypt in total production, but reliable statistics are not available.
[2] Preliminary estimate

Sugar, raw, cane, and beet: World production, 1900–1925

Year	Production as reported	Three chief producing countries		
		Cuba	India	Java
	Short tons	*Short tons*	*Short tons*	*Short tons*
1900–1	12, 921, 042	712, 159	2, 549, 958	819, 493
1901–2	14, 017, 184	952, 203	2, 265, 173	891, 236
1902–3	12, 991, 634	1, 118, 738	2, 135, 598	982, 781
1903–4	13, 228, 731	1, 165, 055	2, 096, 624	1, 022, 836
1904–5	13, 066, 932	1, 302, 849	2, 429, 000	1, 159, 866
1905–6	15, 202, 891	1, 320, 199	1, 932, 560	1, 146, 037
1906–7	15, 789, 808	1, 598, 994	2, 469, 936	1, 092, 053
1907–8	15, 189, 827	1, 077, 393	2, 292, 528	1, 215, 530
1908–9	15, 846, 662	1, 694, 965	2, 097, 648	1, 274, 306
1909–10	16, 730, 318	2, 020, 871	2, 480, 700	1, 368, 755
1910–11	18, 680, 900	1, 661, 465	2, 587, 100	1, 411, 275
1911–12	17, 765, 546	2, 123, 502	2, 744, 900	1, 616, 599

Sugar, raw, cane, and beet: World production, 1900–1925—Continued

Year	Production as reported	Three chief producing countries		
		Cuba	India	Java
	Short tons	*Short tons*	*Short tons*	*Short tons*
1912–13	20, 117, 285	2, 719, 961	2, 861, 500	1, 550, 274
1913–14	20, 793, 711	2, 909, 460	2, 573, 200	1, 615, 944
1914–15	20, 613, 043	2, 921, 984	2, 736, 000	1, 548, 668
1915–16	18, 887, 512	3, 398, 385	2, 949, 000	1, 454, 030
1916–17	18, 508, 744	3, 421, 597	3, 093, 000	1, 796, 558
1917–18	20, 172, 700	3, 889, 966	3, 839, 000	2, 008, 521
1918–19	18, 279, 267	4, 490, 902	2, 752, 000	1, 960, 118
1919–20	17, 841, 625	4, 183, 676	3, 404, 000	1, 472, 796
1920–21	19, 198, 455	4, 406, 413	2, 825, 000	1, 681, 338
1921–22	20, 143, 474	4, 517, 470	2, 928, 000	1, 853, 357
1922–23	20, 496, 234	4, 083, 483	3, 410, 000	1, 989, 170
1923–24	22, 002, 561	4, 606, 223	3, 715, 000	1, 980, 653
1924–25	24, 170, 700	5, 812, 068	2, 841, 000	2, 201, 368
1925–26 [1]	----------	5, 927, 840	3, 274, 000	2, 531, 126

Year	Production in United States and possessions [2]	Consumption in United States [1,3]	
		Total	Per capita
	Short tons	*Short tons*	*Pounds*
1900–1	901, 413	2, 792, 615	72. 6
1901–2	1, 082, 705	2, 509, 436	63. 9
1902–3	1, 252, 984	3, 190, 856	79. 6
1903–4	1, 107, 100	2, 847, 482	69. 6
1904–5	1, 359, 715	3, 037, 799	72. 8
1905–6	1, 485, 861	3, 255, 814	76. 6
1906–7	1, 535, 255	3, 547, 248	81. 9
1907–8	1, 776, 328	3, 297, 204	74. 7
1908–9	1, 776, 409	3, 644, 716	81. 1
1909–10	1, 848, 854	3, 672, 754	80. 3
1910–11	1, 946, 531	3, 655, 858	78. 6
1911–12	2, 131, 534	3, 975, 044	84. 2
1912–13	2, 144, 734	4, 169, 506	87. 0
1913–14	2, 405, 944	4, 451, 382	91. 6
1914–15	2, 382, 356	4, 348, 464	88. 2
1915–16	2, 501, 467	3, 986, 667	79. 7
1916–17	2, 704, 567	4, 248, 276	83. 7
1917–18	2, 516, 286	4, 083, 508	79. 4
1918–19	2, 505, 010	4, 407, 761	84. 5
1919–20	2, 356, 286	4, 915, 248	93. 0
1920–21	2, 885, 031	5, 332, 344	99. 6
1921–22	2, 881, 704	5, 621, 022	103. 6
1922–23	2, 362, 232	5, 912, 418	107. 5
1923–24	2, 713, 484	5, 670, 609	101. 8

[1] Preliminary.
[2] Figures since 1924 not available.
[3] Quantity available for consumption without taking account of carry over.

U. S. D. A.—10-1-26

Acreage and yield per acre of important crops, by States, 1923–1925

CORN

State	Acreage			Yield per acre		
	1923	1924	1925 [1]	1923	1924	1925 [1]
	1,000 acres	*1,000 acres*	*1,000 acres*	*Bush.*	*Bush.*	*Bush.*
Maine	18	12	13	38.0	43.0	45.0
New Hampshire	26	14	15	42.0	48.0	50.0
Vermont	93	83	85	39.0	47.0	48.0
Massachusetts	63	41	42	43.0	45.0	50.0
Rhode Island	12	8	9	38.0	40.0	45.0
Connecticut	76	55	57	41.0	43.0	50.0
New York	758	677	691	32.4	34.0	36.0
New Jersey	236	195	206	40.0	34.0	52.0
Pennsylvania	1,541	1,316	1,421	40.0	36.5	51.0
Delaware	183	140	145	33.1	27.0	37.0
Maryland	642	537	568	39.3	31.0	45.0
Virginia	1,914	1,499	1,639	29.0	21.0	22.0
West Virginia	616	460	506	34.0	26.0	36.5
North Carolina	2,603	2,317	2,271	22.5	18.0	18.5
South Carolina	1,980	1,650	1,584	16.5	12.0	12.3
Georgia	4,034	3,975	3,895	12.2	11.5	10.7
Florida	820	600	580	12.5	13.5	15.0
Ohio	3,899	3,432	3,707	41.0	26.0	48.0
Indiana	5,003	4,450	4,628	38.5	25.6	43.5
Illinois	8,995	8,946	9,240	37.5	33.0	42.0
Michigan	1,686	1,610	1,642	34.5	28.5	40.0
Wisconsin	2,253	2,185	2,141	37.0	26.0	46.5
Minnesota	4,297	4,586	4,357	36.0	27.0	36.0
Iowa	10,776	10,912	11,130	40.5	28.0	43.0
Missouri	6,562	6,500	6,825	30.0	24.0	29.5
North Dakota	842	1,320	1,056	33.5	20.0	23.5
South Dakota	4,208	4,814	4,766	34.5	21.3	17.5
Nebraska	8,244	8,716	9,100	33.0	22.0	26.0
Kansas	5,629	6,021	6,623	21.7	21.7	15.8
Kentucky	3,300	3,048	3,200	28.5	25.0	26.5
Tennessee	3,018	3,100	3,162	24.5	21.5	20.0
Alabama	3,150	2,900	2,797	14.0	12.5	13.5
Mississippi	2,327	2,240	1,977	14.5	12.0	18.0
Louisiana	1,604	1,250	1,225	15.4	11.5	18.0
Texas	5,000	3,943	3,154	18.5	16.0	8.5
Oklahoma	3,264	2,862	2,558	11.5	19.0	7.5
Arkansas	2,000	2,090	2,006	15.5	16.0	14.0
Montana	365	420	399	26.0	18.0	16.5
Wyoming	150	180	191	27.0	12.0	23.0
Colorado	1,505	1,450	1,494	25.0	10.0	15.0
New Mexico	221	220	175	16.4	18.0	18.0
Arizona	33	31	39	30.0	22.0	20.0
Utah	31	15	18	24.9	20.0	23.3
Nevada	1	2	2	23.3	22.4	25.0
Idaho	73	66	78	42.0	30.7	41.0
Washington	74	43	58	37.0	30.0	35.0
Oregon	71	59	71	35.0	30.5	29.0
California	128	86	85	35.0	33.8	35.1
United States	104,324	101,076	101,631	29.3	22.9	28.5

[1] Preliminary.

Acreage and yield per acre of important crops, by States, 1923–1925—Continued

WHEAT

State	Acreage			Yield per acre		
	1923	1924	1925[1]	1923	1924	1925[1]
	1,000 acres	*1,000 acres*	*1,000 acres*	*Bush.*	*Bush.*	*Bush.*
Maine	5	4	6	26.0	26.0	28.0
Vermont	4	1	2	21.0	21.0	21.0
New York	403	327	308	20.2	18.7	19.5
New Jersey	74	54	58	20.0	18.5	21.0
Pennsylvania	1,283	1,136	1,136	19.0	16.5	20.0
Delaware	106	100	103	18.0	17.8	18.5
Maryland	600	510	520	19.2	15.8	21.0
Virginia	838	630	630	13.3	13.4	14.2
West Virginia	228	122	128	13.0	13.0	13.5
North Carolina	544	414	406	11.1	12.0	11.0
South Carolina	175	57	46	11.0	11.0	11.5
Georgia	189	76	99	9.2	9.5	10.5
Ohio	2,350	1,857	1,598	18.2	18.0	15.0
Indiana	2,076	1,704	1,772	16.5	17.0	14.5
Illinois	3,479	2,307	2,231	18.0	16.1	16.1
Michigan	976	840	823	17.0	24.0	17.0
Wisconsin	119	116	120	16.6	24.0	20.1
Minnesota	1,840	1,716	2,200	12.7	22.1	13.2
Iowa	731	455	412	18.5	20.2	16.9
Missouri	2,830	1,607	1,671	13.0	13.3	13.2
North Dakota	9,650	8,500	9,605	7.4	15.7	11.7
South Dakota	2,870	2,408	2,747	9.6	15.0	11.8
Nebraska	3,174	3,061	2,676	9.9	19.1	12.8
Kansas	8,299	9,817	8,601	10.1	16.3	8.7
Kentucky	620	200	236	12.4	10.3	14.0
Tennessee	443	310	367	10.2	10.5	12.5
Alabama	15	6	7	10.0	10.0	11.0
Mississippi	4	5	5	15.0	12.4	18.0
Texas	1,559	1,365	819	10.5	18.5	8.0
Oklahoma	3,450	3,556	3,449	11.0	16.0	8.2
Arkansas	70	33	30	11.0	11.5	13.0
Montana	3,274	3,163	3,221	14.6	16.4	10.7
Wyoming	175	141	149	15.9	15.2	17.6
Colorado	1,407	1,360	1,148	13.0	14.4	12.7
New Mexico	108	215	80	12.0	14.2	6.2
Arizona	42	32	32	26.0	21.0	21.0
Utah	272	201	233	24.1	16.5	25.5
Nevada	20	14	15	25.4	22.9	31.2
Idaho	1,052	827	926	28.6	19.4	28.1
Washington	2,446	1,850	2,072	25.0	14.3	17.8
Oregon	1,111	890	910	24.1	16.5	20.8
California	748	377	603	21.6	15.0	19.0
United States	59,659	52,364	52,200	13.4	16.5	12.8

RICE

State	1923	1924	1925[1]	1923	1924	1925[1]
South Carolina	8	5	5	25.0	14.0	16.0
Georgia	3	3	3	22.7	17.0	17.0
Florida	2	--------	--------	23.0	24.0	-------
Mississippi	1	1	1	18.0	10.0	18.0
Louisiana	495	440	450	33.5	34.6	33.3
Texas	145	146	168	40.0	44.7	36.0
Arkansas	135	164	174	39.5	42.7	46.2
California	106	90	103	53.5	48.5	46.0
United States	895	849	904	37.7	39.2	37.6

[1] Preliminary.

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Acreage and yield per acre of important crops, by States, 1923–1925—Continued

RYE

State	Acreage			Yield per acre		
	1923	1924	1925[1]	1923	1924	1925[1]
	1,000 acres	*1,000 acres*	*1,000 acres*	*Bush.*	*Bush.*	*Bush.*
Massachusetts	3	3	3	18.0	20.0	21.0
Connecticut	5	4	4	18.0	18.0	19.0
New York	58	40	37	16.3	17.0	16.5
New Jersey	65	47	44	17.8	17.5	18.0
Pennsylvania	215	120	108	17.0	16.0	17.0
Delaware	6	5	5	14.4	13.5	15.0
Maryland	17	15	18	15.8	15.0	19.0
Virginia	42	36	36	12.0	11.5	12.0
West Virginia	10	10	10	10.0	11.2	13.0
North Carolina	75	71	71	10.4	9.0	11.5
South Carolina	7	7	7	10.5	11.0	10.5
Georgia	20	20	20	9.0	9.2	9.3
Ohio	84	60	66	15.5	16.0	15.0
Indiana	299	161	153	14.0	13.5	11.4
Illinois	230	100	90	15.0	14.5	13.8
Michigan	467	240	216	14.0	14.5	12.5
Wisconsin	342	332	256	14.8	17.0	14.8
Minnesota	912	640	500	13.5	22.0	14.5
Iowa	51	39	35	17.6	18.0	16.4
Missouri	26	20	25	12.5	13.5	12.0
North Dakota	1,320	1,257	1,571	7.8	15.6	10.0
South Dakota	304	236	201	11.5	14.0	9.5
Nebraska	132	189	205	12.0	14.5	12.3
Kansas	41	40	43	8.5	14.2	8.9
Kentucky	20	16	17	11.7	11.0	13.0
Tennessee	20	18	20	10.0	11.0	11.0
Alabama	1	1	1	12.0	11.0	8.0
Texas	17	17	14	12.0	16.0	4.0
Oklahoma	37	37	33	12.0	14.0	12.0
Arkansas	1	1	1	9.0	11.0	11.0
Montana	156	80	112	11.0	14.0	12.5
Wyoming	24	44	47	13.0	10.0	12.0
Colorado	77	74	85	12.0	9.0	10.0
New Mexico	2	2	1	12.0	16.0	4.0
Utah	11	9	5	11.4	9.0	11.0
Idaho	14	3	3	19.0	10.0	20.0
Washington	23	10	15	15.7	7.9	11.0
Oregon	37	15	10	15.0	10.0	14.0
United States	5,171	4,019	4,088	12.2	15.9	11.9

FLAXSEED

State	1923	1924	1925[1]	1923	1924	1925[1]
Wisconsin	8	8	11	12.1	13.0	13.8
Minnesota	527	712	760	10.0	11.4	10.0
Iowa	6	8	9	9.4	11.7	10.5
Missouri	-------	1	1	-------	9.0	7.5
North Dakota	1,050	1,873	1,349	7.7	8.5	6.5
South Dakota	284	548	559	8.5	8.9	6.8
Nebraska	4	8	6	11.0	7.0	9.0
Kansas	24	57	45	7.6	6.5	6.8
Montana	110	246	271	8.2	8.7	4.5
Wyoming	1	-------	-------	10.0	9.0	-------
Colorado	-------	8	1	-------	3.0	4.5
United States	2,014	3,469	3,012	8.5	9.2	7.3

[1] Preliminary.

Acreage and yield per acre of important crops, by States, 1923–1925—Continued

OATS

State	Acreage			Yield per acre		
	1923	1924	1925[1]	1923	1924	1925[1]
	1,000 acres	*1,000 acres*	*1,000 acres*	*Bush.*	*Bush.*	*Bush.*
Maine	125	121	137	37.0	38.0	45.0
New Hampshire	18	16	17	37.5	39.0	39.0
Vermont	75	76	81	35.0	38.0	40.0
Massachusetts	9	8	8	35.0	34.0	38.0
Rhode Island	1	2	2	32.0	30.0	33.0
Connecticut	10	13	14	29.0	29.0	33.0
New York	1,017	970	1,050	32.2	36.0	36.0
New Jersey	68	59	64	24.0	30.0	30.0
Pennsylvania	1,170	1,076	1,227	29.0	36.0	35.0
Delaware	7	4	4	26.0	30.0	25.0
Maryland	59	48	58	29.8	34.0	32.0
Virginia	163	226	271	22.0	23.5	21.5
West Virginia	196	165	196	24.0	24.0	27.0
North Carolina	300	258	258	22.0	18.0	19.0
South Carolina	447	360	378	24.0	19.5	19.0
Georgia	521	275	413	18.0	15.5	17.0
Florida	33	11	13	12.0	13.5	14.0
Ohio	1,516	1,665	2,081	34.5	41.0	41.5
Indiana	1,739	1,850	2,109	28.0	37.0	28.0
Illinois	3,860	4,374	4,724	35.0	39.0	32.0
Michigan	1,528	1,600	1,664	32.0	38.8	32.0
Wisconsin	2,539	2,590	2,603	36.3	40.0	48.5
Minnesota	4,200	4,629	4,814	37.0	43.0	42.0
Iowa	5,774	5,855	6,089	36.2	42.0	40.5
Missouri	1,380	1,630	1,891	25.0	25.0	26.0
North Dakota	2,388	2,841	2,415	23.0	33.0	27.0
South Dakota	2,304	2,889	2,947	34.0	37.0	34.0
Nebraska	2,456	2,456	2,699	33.0	28.0	27.4
Kansas	1,338	1,369	1,712	26.1	25.0	23.0
Kentucky	225	235	247	21.0	23.2	21.0
Tennessee	205	177	221	21.0	21.0	22.0
Alabama	277	125	131	17.0	15.0	17.0
Mississippi	120	75	85	19.0	16.0	19.0
Louisiana	56	25	30	22.0	20.0	21.0
Texas	1,370	1,455	1,091	32.0	34.0	12.3
Oklahoma	1,200	1,200	1,140	20.0	25.0	23.0
Arkansas	250	275	261	23.0	18.0	16.0
Montana	673	570	638	33.0	29.5	22.5
Wyoming	165	125	134	34.0	30.0	35.0
Colorado	226	232	230	32.0	25.0	27.0
New Mexico	58	56	36	20.0	20.0	20.0
Arizona	19	10	12	30.0	28.0	30.0
Utah	81	62	68	37.8	33.1	47.0
Nevada	3	2	2	35.4	34.0	45.0
Idaho	170	155	170	46.0	36.0	49.0
Washington	210	175	254	57.0	38.5	44.0
Oregon	270	280	320	39.0	28.0	33.0
California	162	86	151	32.5	20.8	34.4
United States	40,981	42,756	45,160	31.9	35.6	33.3

[1] Preliminary.

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Acreage and yield per acre of important crops, by States, 1923–1925—Continued

BARLEY

State	Acreage			Yield per acre		
	1923	1924	1925[1]	1923	1924	1925[1]
	1,000 acres	*1,000 acres*	*1,000 acres*	*Bush.*	*Bush.*	*Bush.*
Maine	4	4	5	30.0	26.0	35.0
New Hampshire	1	1	1	26.5	26.0	28.0
Vermont	9	9	10	29.0	31.0	32.0
New York	190	140	163	26.8	30.6	29.0
Pennsylvania	12	14	19	22.4	26.5	25.5
New Jersey		1	1		29.0	27.0
Maryland	4	11	15	33.0	33.0	33.0
Virginia	10	15	16	27.0	27.0	26.0
Ohio	74	55	110	27.0	28.0	31.0
Indiana	30	19	25	23.0	24.0	23.0
Illinois	228	225	270	29.0	32.0	33.0
North Carolina		7	10		23.0	23.0
Michigan	150	115	126	24.0	29.3	24.5
Wisconsin	465	391	461	28.5	32.0	36.8
Minnesota	962	924	1,121	25.0	32.0	30.0
Iowa	158	136	184	28.5	31.0	31.0
Missouri	6	4	5	27.0	25.0	31.0
North Dakota	1,250	1,446	1,908	17.5	25.0	22.5
South Dakota	890	790	908	22.5	27.0	26.0
Nebraska	339	251	233	28.0	25.0	24.3
Kansas	924	447	380	22.2	16.5	11.3
Kentucky	7	5	6	27.0	24.0	26.0
Tennessee	17	20	22	23.0	20.0	23.0
Texas	108	166	116	24.0	25.0	7.2
Montana	105	104	156	25.5	25.0	21.0
Oklahoma	129	209	126	22.0	23.0	14.0
Wyoming	28	25	34	30.0	29.0	33.0
Colorado	300	327	410	29.0	20.0	21.0
New Mexico	11	6	5	19.0	15.0	17.0
Arizona	36	20	20	35.0	30.0	35.0
Utah	22	14	18	40.6	28.5	43.0
Nevada	5	6	8	25.4	39.8	48.0
Idaho	93	118	124	43.0	31.0	44.0
Washington	85	70	91	45.7	22.6	34.0
Oregon	88	65	96	35.0	22.0	33.0
California	1,095	698	1,040	30.2	21.3	31.0
United States	7,835	6,858	8,243	25.2	26.0	26.4

BUCKWHEAT

Maine	10	12	16	23.0	24.0	26.0
New Hampshire	1	1	1	22.0	23.0	24.0
Vermont	4	4	4	18.0	22.0	22.0
Massachusetts	1	1	1	20.0	19.0	19.0
Connecticut	2	2	2	16.0	19.0	20.0
New York	214	218	235	19.0	21.0	19.0
New Jersey	10	3	4	21.0	19.0	21.0
Pennsylvania	227	207	211	21.5	19.0	23.0
Delaware	8	7	8	18.0	16.8	16.0
Maryland	9	7	7	22.1	17.5	24.0

[1] Preliminary.

Acreage and yield per acre of important crops, by States, 1923–1925—Continued

BUCKWHEAT—Continued

State	Acreage			Yield per acre		
	1923	1924	1925[1]	1923	1924	1925[1]
	1,000 acres	*1,000 acres*	*1,000 acres*	*Bush.*	*Bush.*	*Bush.*
Virginia	18	17	15	19.3	17.3	16.0
West Virginia	33	31	32	20.0	17.0	18.0
North Carolina	9	10	10	22.0	18.0	14.0
Ohio	23	34	27	20.0	16.0	19.7
Indiana	6	16	16	17.0	14.0	13.2
Illinois	6	10	9	15.0	14.0	14.0
Michigan	53	50	55	14.2	14.0	13.7
Wisconsin	28	23	35	14.0	13.0	16.0
Minnesota	49	57	61	13.0	12.0	14.0
Iowa	5	6	5	15.0	15.0	17.5
Missouri	1	1	1	13.0	13.0	14.0
South Dakota	9	10	10	14.0	14.8	12.0
Nebraska	1	1	1	18.0	15.0	14.0
Kentucky	9	7	7	18.0	14.0	12.5
Tennessee	3	3	3	19.0	19.0	15.0
United States	739	738	776	18.9	18.0	18.9

POTATOES

State	Acreage 1923	Acreage 1924	Acreage 1925[1]	Yield 1923	Yield 1924	Yield 1925[1]
Maine	124	140	134	258	315	255
New Hampshire	13	11	11	190	170	145
Vermont	24	21	21	200	160	125
Massachusetts	26	15	15	180	150	140
Rhode Island	2	2	2	165	140	140
Connecticut	22	15	15	160	130	135
New York	323	310	279	123	140	86
New Jersey	82	67	57	95	150	106
Pennsylvania	249	215	207	105	118	123
Delaware	10	7	6	80	91	64
Maryland	49	42	44	80	95	73
Virginia	152	140	126	93	131	90
West Virginia	49	45	47	120	95	87
North Carolina	50	59	58	86	105	78
South Carolina	32	30	25	103	111	87
Georgia	22	20	17	70	72	49
Florida	19	29	23	92	88	113
Ohio	126	108	113	98	88	106
Indiana	75	52	50	105	99	83
Illinois	104	80	76	92	110	60
Michigan	314	260	237	114	130	103
Wisconsin	272	242	211	96	130	112
Minnesota	399	340	276	102	132	97
Iowa	81	79	83	84	136	63
Missouri	93	85	88	100	98	57
North Dakota	158	125	88	83	92	70
South Dakota	88	70	61	88	82	65
Nebraska	111	89	84	80	87	75
Kansas	55	54	54	86	95	67
Kentucky	58	48	46	85	100	60

[1] Preliminary.

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Acreage and yield per acre of important crops, by States, 1923–1925—Continued

POTATOES—Continued

State	Acreage			Yield per acre		
	1923	1924	1925[1]	1923	1924	1925[1]
	1,000 acres	*1,000 acres*	*1,000 acres*	*Bush.*	*Bush.*	*Bush.*
Tennessee	32	35	37	90	80	56
Alabama	44	28	25	80	90	57
Mississippi	15	12	10	74	81	67
Louisiana	26	28	30	63	68	60
Texas	35	25	26	55	67	53
Oklahoma	42	32	39	66	70	72
Arkansas	33	26	28	59	74	60
Montana	36	34	35	110	88	108
Wyoming	18	15	14	100	95	120
Colorado	110	88	86	123	150	165
New Mexico	3	2	2	50	52	75
Arizona	4	3	3	60	54	57
Utah	16	14	15	168	136	180
Nevada	5	4	4	174	150	225
Idaho	67	65	67	180	170	196
Washington	52	51	54	155	150	145
Oregon	44	40	42	95	96	104
California	52	46	42	150	160	155
United States	3,816	3,348	3,113	109.0	127.0	103.8

COTTON

State	Acreage			Yield per acre		
	1923	1924	1925[1]	1923	1924	1925[1]
	1,000 acres	*1,000 acres*	*1,000 acres*	*Lbs.*	*Lbs.*	*Lbs.*
Virginia	74	102	100	325	181	250
North Carolina	1,679	2,005	2,017	290	196	261
South Carolina	1,965	2,404	2,654	187	160	160
Georgia	3,421	3,046	3,589	82	157	155
Florida	147	80	101	40	130	180
Alabama	3,079	3,055	3,504	91	154	185
Mississippi	3,170	2,981	3,466	91	176	275
Louisiana	1,405	1,616	1,874	125	146	232
Texas	14,150	17,175	17,608	147	138	113
Arkansas	3,026	3,094	3,738	98	169	205
Tennessee	1,172	996	1,173	92	170	210
Missouri	355	493	520	171	187	275
Oklahoma	3,197	3,861	5,214	98	187	155
California	233	130	169	285	285	340
Arizona	127	180	162	292	285	350
New Mexico	60	101	107	230	270	298
Other	13	41	57	226	163	214
United States	37,123	41,360	46,053	130.6	157.6	167.2

[1] Preliminary.

Acreage and yield per acre of important crops, by States, 1923–1925—Continued

TOBACCO

State	Acreage			Yield per acre		
	1923	1924	1925[1]	1923	1924	1925[1]
	1,000 acres	*1,000 acres*	*1,000 acres*	*Lbs.*	*Lbs.*	*Lbs.*
Massachusetts	9	9	9	1,410	1,340	1,380
Connecticut	29	29	28	1,388	1,370	1,425
New York	2	2	2	1,125	1,175	1,100
Pennsylvania	45	46	41	1,310	1,250	1,400
Maryland	27	32	30	792	704	823
Virginia	204	210	189	740	650	630
West Virginia	9	8	9	860	775	775
North Carolina	585	497	547	700	560	660
South Carolina	102	94	96	730	485	740
Georgia	17	40	67	661	777	717
Florida	4	6	7	1,073	750	780
Ohio	47	58	52	910	705	980
Indiana	22	21	17	899	893	871
Wisconsin	44	38	32	1,093	940	1,375
Missouri	6	5	5	1,100	1,100	815
Kentucky	578	485	485	855	836	810
Tennessee	146	125	130	750	795	725
Louisiana	1	1	1	465	400	504
United States	1,877	1,706	1,747	807.2	728.3	772.6

SWEET POTATOES

State	1923	1924	1925[1]	1923	1924	1925[1]
	1,000 acres	*1,000 acres*	*1,000 acres*	*Bush.*	*Bush.*	*Bush.*
New Jersey	18	17	18	122	140	117
Pennsylvania	2	2	2	130	117	115
Delaware	9	10	11	112	130	110
Maryland	9	8	10	130	140	129
Virginia	44	35	37	120	120	108
West Virginia	3	3	3	130	110	92
North Carolina	100	80	80	105	92	88
South Carolina	94	50	52	97	68	55
Georgia	137	100	110	84	70	47
Florida	30	25	29	98	84	85
Ohio	3	3	3	112	112	115
Indiana	3	2	2	118	115	108
Illinois	8	8	8	110	108	88
Iowa	4	3	3	70	80	109
Missouri	14	6	6	108	100	95
Kansas	3	3	3	107	113	116
Kentucky	20	12	14	103	80	90
Tennessee	35	30	36	110	95	90
Alabama	113	60	65	104	73	70
Mississippi	101	50	62	98	51	96
Louisiana	78	60	72	90	50	80
Texas	86	70	84	80	57	73
Oklahoma	30	18	20	90	87	94
Arkansas	40	27	36	95	81	85
New Mexico	1	1	1	134	120	140
Arizona	2	2	2	170	125	130
California	6	6	9	115	113	123
United States	993	691	778	97.9	79.0	80.3

[1] Preliminary.

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Acreage and yield per acre of important crops, by States, 1923–1925—Continued

PEANUTS

State	Acreage			Yield per acre		
	1923	1924	1925[1]	1923	1924	1925[1]
	1,000 acres	*1,000 acres*	*1,000 acres*	*Lbs.*	*Lbs.*	*Lbs.*
Virginia	124	120	138	990	650	950
North Carolina	160	210	200	1, 100	845	1, 117
South Carolina	38	22	14	800	650	430
Georgia	152	399	278	512	600	475
Florida	80	47	41	600	710	600
Tennessee	14	23	20	935	730	815
Alabama	142	270	180	469	500	560
Mississippi	15	14	14	600	480	595
Louisiana	17	9	9	450	355	640
Texas	122	75	71	620	450	505
Oklahoma	15	8	7	650	700	700
Arkansas	17	10	10	650	535	496
United States	896	1, 207	982	722. 9	620. 5	706. 8

GRAIN SORGHUMS

State	Acreage			Yield per acre		
	1,000 acres	*1,000 acres*	*1,000 acres*	*Bush.*	*Bush.*	*Bush.*
Iowa	6	7	7	33. 0	22. 0	23. 2
Missouri	13	63	57	21. 0	15. 0	15. 0
Nebraska	26	25	20	25. 6	18. 0	15. 0
Kansas	1, 598	1, 144	1, 100	17. 7	21. 4	16. 9
Texas	1, 891	1, 300	1, 625	22. 0	22. 0	19. 0
Oklahoma	1, 523	975	1, 053	12. 0	20. 0	13. 5
Colorado	360	50	50	20. 0	9. 0	12. 0
New Mexico	205	135	90	18. 0	20. 0	20. 0
Arizona	35	30	30	34. 0	20. 0	22. 0
California	135	84	88	33. 0	30. 5	34. 0
United States	5, 792	3, 813	4, 120	18. 3	21. 1	17. 2

[1] Preliminary.

Acreage and yield per acre of important crops, by States, 1923–1925—Continued

HAY (TAME)

State	Acreage			Yield per acre		
	1923	1924	1925[1]	1923	1924	1925[1]
	1,000 acres	*1,000 acres*	*1,000 acres*	*Short tons*	*Short tons*	*Short tons*
Maine	1,245	1,249	1,249	1.28	1.11	1.21
New Hampshire	441	461	461	1.22	1.11	1.22
Vermont	918	917	920	1.40	1.50	1.57
Massachusetts	434	457	457	1.37	1.28	1.33
Rhode Island	45	47	47	1.24	1.32	1.34
Connecticut	320	352	355	1.32	1.25	1.27
New York	4,919	4,953	4,871	1.36	1.45	1.38
New Jersey	312	265	265	1.05	1.82	1.57
Pennsylvania	2,919	3,087	3,069	1.05	1.61	1.39
Delaware	81	85	82	1.17	1.51	1.37
Maryland	386	426	418	1.05	1.73	1.36
Virginia	1,019	1,030	1,005	1.00	1.36	1.76
West Virginia	753	791	785	1.19	1.52	1.21
North Carolina	784	775	789	1.22	.96	.67
South Carolina	434	355	246	.80	.47	.25
Georgia	772	763	568	.66	.51	.33
Florida	132	88	78	.90	.78	.69
Ohio	3,250	3,331	3,021	1.20	1.59	1.09
Indiana	2,094	2,375	2,236	1.24	1.47	1.01
Illinois	3,280	3,725	3,503	1.30	1.49	1.07
Michigan	3,105	3,050	3,006	1.26	1.56	1.00
Wisconsin	3,187	3,317	3,362	1.33	1.87	1.50
Minnesota	2,016	2,299	2,359	1.25	1.70	1.79
Iowa	3,139	3,362	3,152	1.52	1.78	1.35
Missouri	3,310	3,468	3,399	1.22	1.39	1.14
North Dakota	895	926	896	1.49	1.57	1.62
South Dakota	1,050	1,102	1,153	1.76	1.65	1.32
Nebraska	1,584	1,963	1,672	2.41	2.23	2.17
Kansas	1,630	1,570	1,714	2.20	2.16	2.02
Kentucky	1,130	1,120	1,008	1.36	1.42	1.14
Tennessee	1,354	1,377	1,296	1.15	1.04	.92
Alabama	789	616	591	.80	.72	.69
Mississippi	471	361	393	1.25	.94	1.00
Louisiana	214	264	242	1.44	.73	.90
Texas	723	828	804	1.64	1.17	.81
Oklahoma	936	531	487	1.71	1.59	1.28
Arkansas	576	588	559	1.26	1.10	.80
Montana	1,150	1,206	1,232	1.88	1.73	1.65
Wyoming	730	646	663	1.93	1.80	1.94
Colorado	1,203	1,263	1,245	2.05	2.11	2.15
New Mexico	158	174	171	2.09	2.28	2.26
Arizona	162	158	160	3.56	3.69	3.47
Utah	523	537	568	2.69	2.02	3.30
Nevada	180	207	216	2.67	1.75	3.05
Idaho	1,060	1,073	1,032	2.50	2.17	3.28
Washington	1,005	970	913	2.35	1.86	2.36
Oregon	984	953	900	2.24	1.46	2.07
California	2,066	1,990	1,780	2.55	2.33	3.04
United States	59,868	61,451	59,398	1.49	1.60	1.46

[1] Preliminary.

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Acreage and yield per acre of important crops, by States, 1923–1925—Continued

HAY (WILD)

State	Acreage			Yield per acre		
	1923	1924	1925[1]	1923	1924	1925[1]
	1,000 acres	*1,000 acres*	*1,000 acres*	*Short tons*	*Short tons*	*Short tons*
Maine	16	13	13	1. 10	0. 96	0. 94
New Hampshire	12	17	17	. 94	. 95	. 85
Vermont	13	13	13	1. 00	1. 00	1. 05
Massachusetts	12	12	12	1. 00	1. 00	1. 00
Rhode Island	1	1	1	. 95	. 85	. 85
Connecticut	9	11	11	1. 20	1. 07	1. 05
New York	67	67	68	1. 18	1. 28	1. 12
New Jersey	22	16	16	1. 20	1. 30	1. 60
Pennsylvania	25	25	24	1. 15	1. 35	1. 24
Delaware	2	1	1	1. 36	1. 40	1. 50
Maryland	4	5	4	1. 15	1. 40	1. 10
Virginia	14	17	13	1. 00	1. 25	. 65
West Virginia	11	13	13	1. 00	1. 00	1. 30
North Carolina	100	60	45	1. 00	1. 00	. 62
South Carolina	6	4	4	. 85	. 60	. 33
Georgia	16	20	12	. 90	. 60	. 51
Florida	6	4	4	. 85	. 80	. 75
Ohio	2	12	10	1. 15	1. 14	1. 14
Indiana	24	21	18	1. 15	1. 00	. 90
Illinois	61	41	37	1. 15	1. 35	1. 00
Michigan	52	41	41	1. 20	1. 25	. 97
Wisconsin	368	197	256	1. 30	1. 30	1. 30
Minnesota	2, 041	2, 070	2, 070	1. 15	1. 17	1. 20
Iowa	401	318	300	1. 20	1. 26	1. 00
Missouri	125	151	130	1. 10	1. 22	. 86
North Dakota	2, 222	1, 971	1, 774	1. 00	. 95	. 95
South Dakota	3, 491	2, 941	2, 819	1. 20	. 75	. 62
Nebraska	2, 296	2, 976	2, 976	1. 10	1. 00	. 75
Kansas	892	991	938	1. 18	1. 13	. 84
Kentucky	23	23	23	1. 00	1. 20	1. 05
Tennessee	55	50	47	1. 10	1. 00	. 65
Alabama	25	22	22	. 80	. 50	. 62
Mississippi	43	38	32	1. 20	. 60	. 75
Louisiana	18	18	18	1. 20	1. 00	. 70
Texas	207	215	211	1. 10	1. 00	. 45
Oklahoma	520	530	424	. 98	1. 10	. 66
Arkansas	126	150	127	1. 21	. 75	. 70
Montana	653	673	650	. 91	. 90	. 90
Wyoming	315	380	380	1. 05	. 90	1. 05
Colorado	373	360	360	1. 05	1. 00	1. 00
New Mexico	40	32	35	. 80	. 80	. 80
Arizona	12	4	5	1. 25	. 50	. 75
Utah	117	70	77	1. 52	1. 05	1. 70
Nevada	181	125	181	1. 09	. 81	1. 29
Idaho	132	100	101	1. 20	. 75	1. 50
Washington	27	27	30	1. 58	1. 00	1. 55
Oregon	226	120	235	1. 10	. 75	1. 20
California	152	114	148	1. 00	. 74	1. 40
United States	15, 556	15, 080	14, 746	1. 12	. 98	. 88

[1] Preliminary.

Sugar beets and beet sugar: Acreage and production by States where sugar was made, 1923–1925

State and year	Factories in operation	Sugar made	Average extraction	Average sugar content	Beets worked in factories[1]		Average price per ton
					Quantity	Area on which produced	
	Number	*1,000 short tons*	*Per ct.*	*Per ct.*	*1,000 short tons*	*1,000 acres*	*Dollars*
Ohio:							
1923	5	39	10.54	13.39	367	41	9.26
1924	5	45	15.15	17.85	297	41	9.48
1925[2]	5	34	10.09	13.06	337	37	------
Michigan:[3]							
1923	16	110	13.51	15.29	815	109	9.38
1924	16	165	16.63	18.55	992	150	8.85
1925[2]	16	122	12.14	13.33	1,005	115	------
Wisconsin:							
1923	4	14	12.33	15.71	113	15	8.72
1924	4	18	14.06	17.19	128	21	7.02
1925[2]	4	13	11.11	14.53	117	12	------
Nebraska:							
1923	5	74	12.32	14.48	597	58	8.10
1924	5	105	14.64	16.46	717	65	7.53
1925[2]	5	110	12.56	14.38	876	59	------
Montana and Wyoming:							
1923	4	55	13.97	15.88	397	37	8.76
1924	4	81	15.67	17.21	517	54	8.18
1925[2]	6	79	13.08	15.23	604	56	------
Colorado:							
1923	16	240	12.73	14.59	1,890	164	8.15
1924	16	364	15.15	16.65	2,403	225	7.59
1925[2]	16	211	12.85	14.25	1,642	136	------
Utah:							
1923	17	137	13.59	15.66	1,008	83	8.28
1924	17	76	14.07	16.30	540	81	6.92
1925[2]	15	135	13.64	15.86	990	67	------
Idaho:							
1923	9	68	14.64	16.39	467	43	8.57
1924	8	38	15.08	17.06	252	39	7.19
1925[2]	7	72	15.32	17.02	470	38	------
California:							
1923	6	100	17.33	18.35	579	61	13.99
1924	8	131	16.73	18.26	783	84	9.14
1925[2]	7	88	18.11	19.14	486	76	------
Other States:							
1923	7	44	12.16	14.46	352	46	8.93
1924	7	67	15.02	17.03	446	57	7.24
1925[2]	7	49	10.52	13.30	466	57	------
United States:[3]							
1923	89	881	13.37	15.30	6,585	657	8.99
1924	90	1,090	15.41	17.19	7,075	817	7.95
1925[2]	88	913	13.06	14.86	6,993	653	------

[1] Beets used by the factories; not the beets grown in each State.
[2] Preliminary.
[3] Including beets grown in Canada for Michigan factories.

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Louisiana cane sugar: Production, 1921–1924

Year	Acreage of cane used for sugar	Cane used for sugar	Average sugar per ton of cane	Sugar made
	Acres	*Short tons*	*Pounds*	*Short tons*
1921	226, 366	4, 180, 780	155. 2	324, 431
1922	241, 433	3, 778, 110	156. 2	295, 095
1923	217, 259	2, 386, 648	135. 8	162, 023
1924	162, 640	1, 228, 339	144. 1	88, 483
1925 [1]	190, 248	2, 644, 535	105. 4	139, 381

[1] Preliminary.

Cane sirup: Production, 1923–1925

State	Area of sugar cane harvested for sirup [1]			Production of sirup [2]		
	1923	1924	1925 [3]	1923	1924	1925 [3]
	Acres	*Acres*	*Acres*	*1,000 gallons*	*1,000 gallons*	*1,000 gallons*
South Carolina	8, 800	10, 000	9, 000	1, 100	1, 250	810
Georgia	37, 800	30, 000	32, 000	5, 103	3, 750	3, 520
Florida	23, 000	9, 000	10, 000	4, 255	1, 800	2, 100
Alabama	62, 000	20, 000	22, 000	9, 920	2, 120	3, 080
Mississippi	29, 600	8, 000	14, 000	5, 565	440	2, 002
Louisiana	27, 100	47, 000	18, 000	6, 718	9, 512	5, 208
Texas	13, 000	18, 000	14, 000	2, 118	1, 476	2, 310
Arkansas	3, 000	3, 000	3, 000	594	210	360
Total	204, 300	145, 000	122, 000	35, 373	20, 558	19, 390

[1] Not including sorghum, which is sometimes confused with sugar cane.
[2] Not including molasses, which is a by-product of sugar manufacture.
[3] Preliminary.

Sorgo sirup: Production, 1923–1925

State	Acreage			Yield per acre			Production		
	1923	1924	1925 [1]	1923	1924	1925 [1]	1923	1924	1925 [1]
	1,000 acres	*1,000 acres*	*1,000 acres*	*Gals.*	*Gals.*	*Gals.*	*1,000 gals.*	*1,000 gals.*	*1,000 gals.*
Virginia	12	12	11	95	95	78	1,140	1,140	858
West Virginia	8	8	8	109	92	80	872	736	640
North Carolina	32	31	28	92	87	68	2,944	2,697	1,904
South Carolina	20	21	20	82	62	39	1,640	1,302	780
Georgia	26	25	19	83	71	45	2,158	1,775	855
Florida	1			110			110		
Ohio	4	4	4	65	75	72	260	300	288
Indiana	11	3	2	80	85	88	880	255	176
Illinois	9	9	10	80	75	77	720	675	770
Wisconsin	2	2	2	56	54	70	112	108	140
Minnesota	2	2	2	95	56	71	190	112	142
Iowa	5	5	5	88	72	79	440	360	395
Missouri	22	22	22	88	81	76	1,936	1,782	1,672
Nebraska	2	2	2	90	80	70	180	160	140
Kansas	3	4	5	70	75	50	210	300	250
Kentucky	46	46	48	93	80	80	4,278	3,680	3,840
Tennessee	30	30	28	92	73	68	2,760	2,190	1,904
Alabama	30	35	42	80	50	70	2,400	1,750	2,940
Mississippi	38	36	34	82	55	76	3,116	1,980	2,584
Louisiana	1	1	1	85	30	75	85	30	1,426
Texas	32	33	31	84	50	46	2,688	1,650	2,584
Oklahoma	16	16	14	57	68	76	912	1,088	1,064
Arkansas	26	36	38	70	58	68	1,820	2,088	75
New Mexico	2	2	1	75	63	65	150	126	65
U. S.	380	385	377	84.2	68.3	67.6	32,001	26,284	25,492

[1] Preliminary.

Maple sugar and sirups: Production, 1923–1925

State	Trees tapped			Production in terms of sugar [1]		
	1923	1924	1925 [2]	1923	1924	1925 [2]
	Thousands	*Thousands*	*Thousands*	*1,000 pounds*	*1,000 pounds*	*1,000 pounds*
Vermont	5,281	5,445	5,554	9,612	12,221	9,442
New York	4,000	4,080	3,998	8,600	9,413	7,792
Ohio	1,879	1,747	1,747	5,712	3,774	2,850
Pennsylvania	831	773	696	2,329	2,304	1,736
Michigan	900	855	838	2,431	1,624	1,507
Indiana	536	536	515	1,469	1,458	1,194
Wisconsin	570	587	575	984	1,288	908
Other [3]	1,294	[4] 1,384	[4] 1,390	2,396	[4] 3,220	[4] 2,519
Total	15,291	15,407	15,313	33,533	35,302	27,948

[1] One gallon of sirup taken as equivalent to 8 pounds of sugar.
[2] Preliminary.
[3] Includes Maine, New Hampshire, Massachusetts, and Connecticut.
[4] Connecticut not reported, 1924–25.

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Crop production: Summary of acreage and production of important crops, United States totals, 1923–1925

[Thousands, i. e., 000 omitted]

Crop	Acreage			Production		
	1923	1924	1925 [1]	1923	1924	1925 [1]
	Acres	*Acres*	*Acres*	*Bushels*	*Bushels*	*Bushels*
Corn	104, 324	101, 076	101, 631	3, 053, 557	2, 312, 745	2, 900, 581
Winter wheat	39, 508	35, 489	31, 269	571, 777	589, 632	398, 486
Spring wheat	20, 151	16, 875	20, 931	225, 617	272, 995	270, 879
Oats	40, 981	42, 756	45, 160	1, 305, 883	1, 522, 665	1, 501, 909
Barley	7, 835	6, 858	8, 243	197, 691	178, 322	218, 002
Rye	5, 171	4, 019	4, 088	63, 077	64, 038	48, 696
Buckwheat	739	738	776	13, 965	13, 277	14, 647
Flaxseed	2, 014	3, 469	3, 012	17, 060	31, 711	22, 007
Rice	895	849	904	33, 717	33, 249	33, 959
Potatoes	3, 816	3, 348	3, 113	416, 105	425, 283	323, 243
Sweet potatoes	993	691	778	97, 177	54, 564	62, 494
Grain sorghum	5, 792	3, 813	4, 120	105, 835	80, 443	71, 050
Clover seed	775	809	789	1, 228	927	1, 020
Beans, dry	1, 344	1, 545	1, 579	16, 308	14, 856	19, 100
Cowpeas	1, 273			19, 090		
Soy beans	492			8, 944		
Apples, total				202, 842	171, 250	164, 616
				Barrels	*Barrels*	*Barrels*
Apples, commercial				35, 936	28, 063	31, 906
				Bushels	*Bushels*	*Bushels*
Peaches				45, 382	54, 119	46, 565
Pears				17, 845	18, 868	19, 820
				Bales	*Bales*	*Bales*
Cotton	37, 123	41, 360	46, 053	[2] 10, 140	[2] 13, 628	16, 106
				Tons	*Tons*	*Tons*
Cottonseed				[2] 4, 502	[2] 6, 051	6, 928
Hay, tame	59, 868	61, 451	59, 398	89, 250	98, 086	86, 474
Hay, wild	15, 556	15, 080	14, 746	17, 361	14, 731	13, 049
Sugar beets	[3] 657	[3] 817	[3] 653	7, 006	7, 513	7, 423
Beet sugar	657	817	653	881	1, 090	913
Cane sugar (La.)	217	163	190	162	88	139
Broomcorn	536	451	200	81	78	29
Velvet beans	620			474		
Cabbage [4]	105	109	108	806	962	869
Grapes				2, 227	1, 764	1, 967
				Pounds	*Pounds*	*Pounds*
Tobacco	1, 877	1, 706	1, 747	1, 515, 110	1, 242, 456	1, 349, 660
Peanuts	896	1, 207	982	647, 762	748, 925	694, 075
Hops	18	20	20	19, 751	27, 670	28, 573
Maple sugar and sirup (as sugar)	[5] 15, 291	15, 407	15, 313	33, 533	35, 302	27, 948
				Boxes	*Boxes*	*Boxes*
Oranges				36, 167	29, 273	32, 946
				Barrels	*Barrels*	*Barrels*
Cranberries	28	28	28	652	562	530
				Gallons	*Gallons*	*Gallons*
Sorgo sirup	380	385	377	32, 001	26, 284	25, 492

[1] Preliminary.
[2] Census. Includes that portion of the cotton grown in Lower California (Old Mexico), that is ginned in the United States.
[3] Includes beets grown in Canada for United States factories.
[4] Commercial crop.
[5] Trees tapped (000 omitted).

Aggregate crop acreage, by States, 1923–1925

[Based on aggregate acreage of corn, wheat, oats, barley, rye, buckwheat, potatoes, sweet potatoes, tobacco, flax, rice, all hay, cotton, peanuts, kafir, beans, broomcorn, hops, and cranberries]

State	Acreage of crops named in heading			Percentage of total acreage in specified crops [2]	Total acreage of all crops (theoretical)		
	1923	1924	1925 [1]		1923	1924	1925 [1]
	1,000 acres	*1,000 acres*	*1,000 acres*		*1,000 acres*	*1,000 acres*	*1,000 acres*
Maine	1,547	1,562	1,581	96	1,611	1,627	1,647
New Hampshire	512	521	523	94	545	554	556
Vermont	1,140	1,128	1,140	93	1,226	1,213	1,226
Massachusetts	571	560	561	86	664	651	652
Rhode Island	61	60	61	84	73	71	73
Connecticut	473	481	486	88	538	547	552
New York	8,081	7,859	7,836	91	8,880	8,636	8,611
New Jersey	898	735	744	86	1,044	855	865
Pennsylvania	7,688	7,244	7,465	97	7,926	7,468	7,696
Delaware	412	359	365	89	463	403	410
Maryland	1,806	1,641	1,692	91	1,985	1,803	1,859
Virginia	4,616	4,060	4,198	93	4,963	4,366	4,514
West Virginia	1,908	1,648	1,729	95	2,008	1,735	1,820
North Carolina	6,989	6,763	6,784	94	7,435	7,195	7,217
South Carolina	5,288	5,038	5,203	92	5,748	5,476	5,655
Georgia	9,304	8,737	9,070	94	9,898	9,295	9,649
Florida	1,273	890	881	89	1,430	1,000	990
Ohio	11,374	10,615	10,788	97	11,726	10,943	11,122
Indiana	11,371	10,671	11,026	96	11,845	11,116	11,485
Illinois	20,291	19,876	20,228	97	20,919	20,491	20,854
Michigan	8,899	8,420	8,424	93	9,569	9,054	9,058
Wisconsin	9,638	9,452	9,503	90	10,709	10,502	10,559
Minnesota	17,243	17,983	18,526	96	17,961	18,732	19,298
Iowa	21,132	21,180	21,409	97	21,786	21,835	22,071
Missouri	14,725	14,038	14,595	96	15,339	14,623	15,203
North Dakota	19,775	20,259	20,662	96	20,599	21,103	21,523
South Dakota	15,498	15,808	16,171	98	15,814	16,131	16,501
Nebraska	18,367	19,735	19,672	97	18,935	20,345	20,280
Kansas	20,503	21,560	21,241	93	22,046	23,183	22,840
Kentucky	5,990	5,227	5,322	95	6,305	5,502	5,602
Tennessee	6,514	6,266	6,546	91	7,158	6,886	7,193
Alabama	7,635	7,083	7,364	93	8,210	7,616	7,918
Mississippi	6,267	5,777	6,060	96	6,528	6,018	6,312
Louisiana	3,914	3,711	3,931	91	4,301	4,078	4,320
Texas	25,464	26,803	25,563	92	27,678	29,134	27,786
Oklahoma	14,616	14,065	14,613	93	15,716	15,124	15,713
Arkansas	6,274	6,458	7,022	93	6,746	6,944	7,551
Montana	6,545	6,530	6,754	87	7,523	7,506	7,763
Wyoming	1,606	1,564	1,622	90	1,784	1,738	1,802
Colorado	5,779	5,526	5,441	85	6,799	6,501	6,401
New Mexico	986	1,166	835	78	1,264	1,495	1,071

[1] Preliminary. [2] Based on census proportions in 1919.

U. S. D. A.—10-1-26

Aggregate crop acreage, by States, 1923–1925—Con.

State	Acreage of crops named in heading			Percentage of total acreage in specified crops [2]	Total acreage of all crops (theoretical)		
	1923	1924	1925 [1]		1923	1924	1925
Arizona	478	475	465	85	562	559	547
Utah	1, 073	922	1, 002	88	1, 219	1, 048	1, 139
Nevada	395	360	428	98	403	367	437
Idaho	2, 706	2, 472	2, 573	91	2, 974	2, 716	2, 827
Washington	3, 923	3, 198	3, 489	86	4, 562	3, 719	4, 057
Oregon	2, 843	2, 434	2, 597	80	3, 554	3, 042	3, 246
California [3]	5, 037	3, 892	4, 466	75	6, 716	5, 189	5, 955
U. S.	349, 428	342, 812	348, 657	93. 8	373, 687	366, 135	372, 426

[1] Preliminary.
[2] Based on census proportions in 1919.
[3] Includes cotton acreage in Lower California (135,000 acres in 1922, 150,000 acres in 1923, and 140,000 acres in 1924).

Livestock Production

Livestock on farms in United States. January 1, 1875–1926

[Thousands, i. e., 000 omitted]

Year	Milk cows	Other cattle	Hogs	Sheep	Horses	Mules
1875	10, 907	16, 313	28, 062	33, 784	9, 504	1, 394
1876	11, 085	16, 785	25, 727	35, 935	9, 935	1, 414
1877	11, 261	17, 956	28, 077	35, 804	10, 155	1, 444
1878	11, 300	19, 223	32, 262	35, 740	10, 330	1, 638
1879	11, 826	21, 408	34, 766	38, 124	10, 939	1, 713
1880 [1]	12, 443	23, 482	47, 682	35, 192	10, 357	1, 813
1881	12, 369	20, 939	36, 248	43, 570	11, 430	1, 721
1882	12, 612	23, 280	44, 122	45, 016	10, 522	1, 835
1883	13, 126	28, 046	43, 270	49, 237	10, 838	1. 871
1884	13, 501	29, 046	44, 201	50, 627	11, 170	1, 914
1885	13, 905	29, 867	45, 143	50, 360	11, 565	1, 973
1886	14, 235	31. 275	46. 092	48, 322	12, 078	2, 053
1887	14, 522	33, 512	44, 613	44, 759	12, 497	2. 117
1888	14, 856	34, 378	44, 347	43, 545	13, 173	2, 192
1889	15, 299	35, 032	50, 302	42, 599	13, 663	2, 258
1890 [1]	16, 512	34. 852	57, 410	35, 395	14, 969	2, 296
1891	16, 020	36, 876	50, 625	43, 431	14, 057	2, 297
1892	16. 416	37, 051	52, 398	44, 938	15, 498	2, 315
1893	16, 424	35, 054	46, 095	47, 274	16, 207	2. 331
1894	16, 487	36, 608	45. 206	45, 048	16, 081	2, 352
1895	16, 505	34, 364	44, 166	42, 294	15, 893	2, 333
1896	16, 138	32, 085	42, 843	38, 299	15. 124	2, 279

[1] Figures for June 1, census returns.

Livestock on farms in United States, January 1, 1875–1926—Continued

[Thousands, i. e., 000 omitted]

Year	Milk cows	Other cattle	Hogs	Sheep	Horses	Mules
1897	15, 942	30, 508	40, 600	36, 819	14, 365	2, 216
1898	15, 841	29, 264	39, 760	37, 657	13, 961	2, 190
1899	15, 990	27, 994	38, 652	39, 114	13, 665	2, 134
1900 [1]	17, 136	50, 584	62, 868	61, 504	18, 267	3, 265
1901	16, 834	45, 500	56, 982	59, 757	16, 745	2, 864
1902	16, 697	44, 728	48, 699	62, 039	16, 531	2, 757
1903	17, 105	44, 659	46, 923	63, 965	16, 557	2, 728
1904	17, 420	43, 629	47, 009	51, 630	16, 736	2, 758
1905	17, 572	43, 669	47, 321	45, 170	17, 058	2, 889
1906	19, 794	47, 068	52, 103	50, 632	18, 719	3, 404
1907	20, 968	51, 566	54, 794	53, 240	19, 747	3, 817
1908	21, 194	50, 073	56, 084	54, 631	19, 992	3, 869
1909	21, 720	49, 379	54, 147	56, 084	20, 640	4, 053
1910 [2]	20, 625	41, 178	58, 186	52, 448	19, 833	4, 210
1911	20, 823	39, 679	65, 620	53, 633	20, 277	4, 323
1912	20, 699	37, 260	65, 410	52, 362	20, 509	4, 362
1913	20, 497	36, 030	61, 178	51, 482	20, 567	4, 386
1914	20, 737	35, 855	58, 933	49, 719	20, 962	4, 449
1915	21, 262	37, 067	64, 618	49, 956	21, 195	4, 479
1916	22, 108	39, 812	67, 766	48, 625	21, 159	4, 593
1917	22, 894	41, 689	67, 503	47, 616	21, 210	4, 723
1918	23, 310	44, 112	70, 978	48, 603	21, 555	4, 873
1919	23, 475	45, 085	74, 584	48, 866	21, 482	4, 954
1920	21, 427	47, 444	59, 813	39, 025	19, 848	5, 475
1921	21, 408	45, 776	58, 711	37, 452	19, 134	5, 586
1922	21, 788	45, 476	59, 355	36, 327	18, 564	5, 638
1923	22, 063	44, 093	68, 447	37, 223	17, 943	5, 702
1924	22, 255	42, 252	65, 937	38, 300	17, 222	5, 730
1925	22, 523	39, 627	55, 769	39, 390	16, 554	5, 758
1926 [3]	22, 290	37, 539	51, 223	40, 748	15, 778	5, 780

[1] Figures for June 1, census returns.
[2] Figures for Apr. 15, census returns.
[3] Preliminary.

Poultry and chickens on farms, and chicken eggs produced, United States, 1919–1925

ON HAND JANUARY 1

[Thousands, i. e., 000 omitted]

Calendar year	All poultry		Chickens	
	Number	Value	Number	Value
1920 (census)	372, 825	$373, 394	359, 537	$349, 509
1921	370, 600	----------	357, 700	319, 415
1922	423, 400	----------	408, 600	330, 015
1923	439, 900	----------	424, 800	316, 940
1924 [1]	487, 700	373, 880	470, 300	348, 105
1925 [1]	442, 800	349, 006	427, 000	336, 177

[1] Preliminary; given as percentages. Revised figures are not available.

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Poultry and chickens on farms, and chicken eggs produced, United States, 1919–1925—Continued

PRODUCTION

[Thousands, i. e., 000 omitted]

Calendar year	Chickens		Chicken eggs	
	Number	Value	Dozen	Value
1919 (census)	473,302	$386,240	1,654,045	$676,137
1920	474,400	412,734	1,647,043	725,188
1921	549,700	392,334	1,888,318	552,616
1922	579,000	378,450	1,970,755	509,592
1923	648,900	417,080	2,176,558	593,648
1924 [1]	678,300	445,018	1,968,276	521,574
1925 [2]				

[1] Preliminary; given as percentages. Revised figures are not available.
[2] Figures not available.

Wool, raw: Production and apparent consumption, United States, 1900–1925

[Thousand pounds, i. e., 000 omitted]

Calendar year	Production			Excess of imports [1] over all exports	Apparent consumption
	Fleece	Pulled	Total		
1900	259,973	28,664	288,637	136,440	425,077
1901	265,502	37,000	302,502	121,541	424,043
1902	274,341	42,000	316,341	172,635	488,976
1903	245,450	42,000	287,450	169,943	457,393
1904	249,783	42,000	291,783	184,224	476,007
1905	253,488	42,000	295,488	242,471	537,959
1906	256,915	42,000	298,915	192,081	490,996
1907	256,295	42,000	298,295	185,111	483,406
1908	270,138	41,000	311,138	135,405	446,543
1909	287,111	41,000	328,111	311,001	639,112
1910	281,363	40,000	321,363	171,032	492,395
1911	277,548	41,000	318,548	152,412	470,960
1912	262,543	41,500	304,043	236,302	540,345
1913	252,675	43,500	296,175	147,877	444,052
1914	247,192	43,000	290,192	253,404	543,596
1915	245,726	40,000	285,726	402,465	688,191
1916	244,890	43,600	288,490	443,143	731,633
1917	241,892	40,000	281,892	417,747	699,639
1918	256,870	42,000	298,870	452,805	751,675
1919	249,958	48,300	298,258	437,364	735,622
1920	235,005	42,900	277,905	238,137	516,042
1921	223,062	48,500	271,562	317,134	588,696
1922	222,560	42,000	264,560	371,795	636,355
1923	224,330	42,500	266,830	369,527	636,357
1924	242,405	43,800	286,205	240,148	526,353
1925 [2]	254,260	46,800	301,060	321,910	622,970

[1] Imports and reexports include hair of camel, goat, alpaca, etc. Imports of hair not separately stated prior to July 1, 1913; since that date they have constituted less than 2 per cent of the total every year except 1915, when they were 2.4 per cent.
[2] Preliminary.

Livestock Movement

Cattle and calves at all public stockyards, by months, 1915–1925

RECEIPTS

[Thousands, i. e., 000 omitted]

Month	1915	1916	1917	1918	1919
January	1,029	1,202	1,696	1,727	2,119
February	768	1,055	1,302	1,498	1,453
March	1,017	1,201	1,330	1,713	1,517
April	987	1,151	1,539	2,046	1,773
May	1,111	1,385	1,961	1,863	1,836
June	1,113	1,319	1,759	1,815	1,588
July	1,039	1,154	1,729	2,128	2,016
August	1,246	1,584	1,814	2,024	2,039
September	1,531	1,779	2,357	2,826	2,396
October	1,818	2,409	3,054	2,865	3,008
November	1,724	1,977	2,626	2,648	2,702
December	1,170	1,460	1,899	2,142	2,182
Total	14,553	17,676	23,066	25,295	24,629

Month	1920	1921	1922	1923	1924	1925
January	1,881	1,644	1,628	1,877	1,888	1,869
February	1,480	1,190	1,416	1,427	1,457	1,530
March	1,663	1,566	1,622	1,502	1,556	1,860
April	1,557	1,494	1,470	1,670	1,751	1,826
May	1,778	1,542	1,878	1,900	1,890	1,737
June	1,879	1,580	1,759	1,629	1,673	1,746
July	1,671	1,343	1,711	1,903	1,798	1,970
August	1,962	1,867	2,149	2,214	1,934	2,245
September	2,294	1,906	2,397	2,295	2,566	2,157
October	2,209	2,310	2,936	2,802	2,736	2,789
November	2,428	1,928	2,427	2,182	2,363	2,282
December	1,395	1,417	1,825	1,810	2,083	2,056
Total	22,197	19,787	23,218	23,211	23,695	24,067

LOCAL SLAUGHTER

Month	1915	1916	1917	1918	1919
January	586	747	1,077	1,088	1,313
February	481	665	817	963	890
March	650	745	817	1,015	912
April	600	680	953	1,237	1,029
May	652	818	1,153	1,080	1,037
June	671	787	1,053	1,058	957
July	639	739	1,059	1,388	1,266
August	682	930	1,100	1,186	1,096
September	719	947	1,229	1,532	1,195
October	765	1,184	1,542	1,534	1,434
November	791	1,135	1,356	1,419	1,312
December	676	917	1,119	1,374	1,192
Total	7,912	10,294	13,275	14,874	13,633

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Cattle and calves at all public stockyards, by months, 1915–1925—Continued

LOCAL SLAUGHTER—Continued

[Thousands, i. e., 000 omitted]

Month	1920	1921	1922	1923	1924	1925
January	1,100	995	927	1,086	1,155	1,150
February	865	728	822	871	915	967
March	1,049	948	994	956	991	1,179
April	951	892	898	1,080	1,108	1,163
May	986	924	1,086	1,173	1,141	1,123
June	1,061	1,005	1,060	990	1,030	1,190
July	933	844	1,001	1,104	1,141	1,252
August	1,035	997	1,106	1,168	1,092	1,281
September	1,172	986	1,107	1,104	1,312	1,227
October	1,050	1,082	1,299	1,373	1,432	1,450
November	1,207	935	1,138	1,106	1,268	1,232
December	785	742	997	1,019	1,265	1,248
Total	12,194	11,078	12,435	13,030	13,850	14,462

STOCKER AND FEEDER SHIPMENTS[1]

Month	1915	1916	1917	1918	1919
January	---------	221	260	222	364
February	---------	197	213	214	264
March	---------	250	249	319	277
April	---------	262	306	385	391
May	---------	289	401	491	442
June	---------	264	353	393	272
July	---------	171	262	274	236
August	---------	330	330	418	397
September	---------	464	588	604	611
October	---------	682	771	704	839
November	---------	461	729	623	723
December	---------	256	344	366	470
Total	---------	3,847	4,806	5,013	5,286

Month	1920	1921	1922	1923	1924	1925
January	349	205	233	281	243	207
February	240	166	243	210	170	176
March	241	236	282	199	174	230
April	244	238	235	233	239	271
May	323	214	359	300	275	216
June	272	209	259	234	201	154
July	218	122	223	223	169	243
August	314	355	469	480	306	360
September	489	395	630	631	580	427
October	580	622	864	785	751	717
November	553	497	710	624	549	489
December	279	245	357	353	309	333
Total	4,102	3,504	4,864	4,553	3,966	3,823

[1] Information for 1915 not obtainable.

Hogs at all public stockyards, by months, 1915–1925

RECEIPTS

[Thousands, i. e., 000 omitted]

Month	1915	1916	1917	1918	1919
January	3, 959	5, 309	5, 084	4, 444	5, 855
February	3, 449	4, 233	3, 933	4, 486	4, 412
March	3, 199	3, 489	3, 369	4, 424	3, 643
April	2, 487	2, 852	2, 961	3, 696	3, 648
May	2, 768	3, 332	3, 264	3, 345	3, 831
June	2, 874	3, 054	2, 791	2, 979	3, 773
July	2, 367	2, 524	2, 563	3, 099	2, 974
August	2, 025	2, 634	1, 853	2, 467	2, 095
September	1, 966	2, 386	1, 615	2, 376	2, 397
October	2, 457	3, 640	2, 676	3, 399	3, 121
November	3, 728	4, 873	3, 941	4, 594	3, 740
December	4, 934	4, 939	3, 992	5, 554	4, 980
Total	36, 213	43, 265	38, 042	44, 863	44, 469

Month	1920	1921	1922	1923	1924	1925
January	5, 262	4, 700	4, 278	5, 306	6, 253	6, 105
February	3, 422	4, 009	3, 613	4, 492	5, 335	4, 558
March	3, 940	3, 386	3, 411	4, 927	4, 833	3, 528
April	3, 024	3, 229	3, 067	4, 318	4, 374	3, 247
May	4, 210	3, 328	3, 737	4, 524	4, 321	3, 283
June	3, 709	3, 579	3, 776	4, 204	4, 296	3, 507
July	2, 811	2, 727	2, 980	4, 181	4, 091	2, 798
August	2, 491	2, 656	3, 037	3, 714	3, 197	2, 549
September	2, 391	2, 655	3, 062	3, 607	3, 216	2, 741
October	2, 789	3, 214	3, 682	4, 816	3, 990	3, 390
November	3, 872	3, 687	4, 421	5, 416	4, 904	3, 843
December	4, 200	3, 931	5, 004	5, 825	6, 604	4, 380
Total	42, 121	41, 101	44, 068	55, 330	55, 414	43, 929

LOCAL SLAUGHTER

Month	1915	1916	1917	1918	1919
January	2, 713	3, 806	3, 338	2, 993	4, 236
February	2, 570	2, 905	2, 528	2, 982	3, 057
March	2, 270	2, 432	2, 209	2, 644	2, 344
April	1, 648	2, 056	2, 103	2, 384	2, 498
May	1, 952	2, 493	2, 361	2, 261	2, 635
June	2, 031	2, 322	1, 968	1, 953	2, 603
July	1, 578	1, 801	1, 805	2, 109	1, 989
August	1, 335	1, 861	1, 259	1, 586	1, 390
September	1, 258	1, 729	1, 051	1, 554	1, 512
October	1, 624	2, 635	1, 796	2, 434	2, 018
November	2, 519	3, 528	2, 422	3, 320	2, 393
December	3, 395	3, 416	2, 600	4, 221	3, 343
Total	24, 893	30, 984	25, 440	30, 441	30, 018

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Hogs at all public stockyards, by months, 1915–1925—Continued

LOCAL SLAUGHTER—Continued

[Thousands, i. e., 000 omitted]

Month	1920	1921	1922	1923	1924	1925
January	3, 529	3, 032	2, 484	3, 395	4, 016	3, 910
February	2, 094	2, 604	2, 286	2, 820	3, 227	3, 010
March	2, 496	2, 120	2, 246	3, 235	2, 976	2, 285
April	1, 861	2, 097	2, 000	2, 924	2, 809	2, 039
May	2, 790	2, 270	2, 571	3, 072	2, 735	1, 931
June	2, 421	2, 475	2, 678	2, 810	2, 852	2, 298
July	1, 716	1, 808	1, 940	2, 652	2, 605	1, 804
August	1, 530	1, 722	1, 976	2, 283	2, 017	1, 586
September	1, 452	1, 697	1, 917	2, 276	1, 959	1, 645
October	1, 726	1, 992	2, 361	3, 129	2, 525	2, 081
November	2, 465	2, 371	2, 918	3, 657	3, 132	2, 300
December	2, 681	2, 147	3, 360	3, 919	4, 335	2, 776
Total	26, 761	26, 335	28, 737	36, 172	35, 188	27, 665

STOCKER AND FEEDER SHIPMENTS[1]

Month	1915	1916	1917	1918	1919
January	---------	10	29	49	51
February	---------	17	28	65	47
March	---------	17	49	95	88
April	---------	11	30	74	127
May	---------	14	28	76	98
June	---------	11	21	53	52
July	---------	9	15	45	44
August	---------	15	25	116	50
September	---------	27	28	116	74
October	---------	26	86	118	111
November	---------	19	319	103	91
December	---------	18	130	79	69
Total	---------	194	788	989	902

Month	1920	1921	1922	1923	1924	1925
January	90	43	27	66	50	38
February	85	51	62	64	47	35
March	107	81	74	69	52	52
April	76	57	56	76	57	41
May	66	39	70	67	46	36
June	43	33	57	63	29	49
July	27	17	31	34	23	35
August	36	23	31	62	25	30
September	47	41	34	102	35	33
October	60	45	50	101	55	45
November	54	33	55	70	40	61
December	37	36	46	46	38	77
Total	728	499	593	820	497	532

[1] Information for 1915 not obtainable.

Sheep at all public stockyards, by months, 1915–1925

RECEIPTS

[Thousands, i. e., 000 omitted]

Month	1915	1916	1917	1918	1919
January	1, 517	1, 450	1, 578	1, 354	1, 594
February	1, 257	1, 280	1, 384	1, 096	1, 157
March	1, 248	1, 156	1, 256	1, 270	1, 268
April	1, 019	1, 144	1, 152	1, 159	1, 438
May	1, 050	1, 347	1, 059	1, 214	1, 468
June	1, 080	1, 394	1, 240	1, 429	1, 775
July	1, 264	1, 451	1, 353	1, 639	2, 287
August	1, 725	1, 984	1, 763	2, 270	3, 360
September	2, 501	2, 650	2, 554	3, 496	3, 854
October	2, 359	3, 231	3, 195	3, 327	3, 754
November	2, 042	2, 126	2, 102	2, 605	2, 845
December	1, 373	1, 479	1, 583	1, 626	2, 456
Total	18, 435	20, 692	20, 219	22, 485	27, 256

Month	1920	1921	1922	1923	1924	1925
January	1, 614	1, 792	1, 835	1, 636	1, 697	1, 467
February	1, 416	1, 516	1, 399	1, 366	1, 412	1, 388
March	1, 315	1, 750	1, 465	1, 430	1, 367	1, 504
April	1, 466	1, 677	1, 227	1, 447	1, 348	1, 541
May	1, 488	1, 916	1, 692	1, 794	1, 344	1, 689
June	1, 640	1, 849	1, 700	1, 426	1, 550	1, 603
July	2, 034	1, 776	1, 677	1, 661	1, 672	1, 609
August	2, 606	2, 500	1, 951	1, 800	2, 005	2, 064
September	2, 895	2, 618	2, 303	2, 659	3, 027	2, 627
October	3, 027	3, 042	3, 311	3, 464	3, 295	3, 198
November	2, 471	2, 068	2, 288	1, 816	1, 879	1, 712
December	1, 566	1, 664	1, 516	1, 526	1, 605	1, 608
Total	23, 538	24, 168	22, 364	22, 025	22, 201	22, 100

LOCAL SLAUGHTER

Month	1915	1916	1917	1918	1919
January	980	930	927	756	969
February	772	821	794	610	733
March	830	753	803	670	726
April	683	708	739	611	842
May	625	850	628	634	834
June	727	893	684	711	945
July	822	887	676	896	1, 204
August	997	1, 090	746	933	1, 166
September	1, 088	1, 104	731	1, 197	1, 353
October	895	1, 203	890	1, 205	1, 451
November	982	1, 057	767	1, 135	1, 210
December	853	932	757	908	1, 213
Total	10, 254	11, 228	9, 142	10, 266	12, 646

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Sheep at all public stockyards, by months, 1915–1925—Continued

LOCAL SLAUGHTER—Continued

[Thousands, i. e., 000 omitted]

Month	1920	1921	1922	1923	1924	1925
January	922	1, 101	925	897	920	786
February	812	935	761	708	725	711
March	792	1, 053	780	805	719	836
April	709	987	678	855	726	833
May	706	1, 015	852	888	723	830
June	845	1, 093	923	790	903	908
July	1, 001	1, 006	956	936	959	938
August	1, 098	1, 335	1, 021	903	978	998
September	1, 217	1, 200	1, 005	894	1, 097	981
October	978	1, 341	1, 067	981	1, 020	945
November	1, 010	988	881	777	775	793
December	891	804	820	837	854	840
Total	10, 981	12, 858	10, 669	10, 271	10, 399	10, 399

STOCKER AND FEEDER SHIPMENTS[1]

Month	1915	1916	1917	1918	1919
January	--------	73	126	128	229
February	--------	77	107	122	131
March	--------	62	68	124	136
April	--------	58	102	221	207
May	--------	67	76	161	160
June	--------	83	146	242	223
July	--------	100	195	212	340
August	--------	340	368	525	1, 039
September	--------	661	968	1, 105	1, 505
October	--------	1, 065	1, 195	1, 245	1, 386
November	--------	546	791	763	860
December	--------	145	306	360	740
Total	--------	3, 277	4, 448	5, 208	6, 956

Month	1920	1921	1922	1923	1924	1925
January	311	88	183	171	149	138
February	140	62	169	169	106	119
March	135	84	143	114	83	94
April	269	107	97	82	105	109
May	234	123	145	216	118	178
June	227	89	191	117	152	137
July	325	139	204	188	226	193
August	568	404	350	341	444	421
September	796	555	534	897	973	857
October	1, 059	731	1, 138	1, 489	1, 441	1, 392
November	857	511	757	540	676	475
December	259	202	256	154	206	220
Total	5, 180	3, 095	4, 167	4, 478	4, 679	4, 332

[1] Information for 1915 not obtainable.

Poultry, dressed: Monthly receipts at Boston, New York, Philadelphia, and Chicago, 1920–1925

[Thousand pounds, i. e., 000 omitted]

Month	1920	1921	1922	1923	1924	1925
January	23, 350	22, 659	22, 250	43, 123	37, 150	27, 585
February	13, 874	13, 634	14, 506	22, 858	26, 395	19, 383
March	8, 411	10, 860	13, 320	16, 752	20, 344	15, 048
April	4, 138	9, 837	11, 512	12, 436	15, 182	13, 323
May	9, 922	10, 402	14, 373	13, 210	17, 319	16, 166
June	11, 168	12, 325	16, 606	16, 205	17, 862	17, 487
July	11, 385	10, 136	13, 703	16, 863	19, 572	17, 676
August	9, 998	15, 463	15, 433	17, 794	17, 543	17, 466
September	12, 783	18, 150	17, 121	18, 399	19, 868	18, 683
October	16, 270	21, 645	21, 434	28, 087	26, 982	27, 259
November	36, 662	47, 259	45, 540	56, 018	60, 445	61, 488
December	56, 148	59, 986	71, 957	73, 100	78, 068	66, 794
Total	214, 109	252, 356	277, 755	334, 845	356, 730	318, 358

Eggs: Cold-storage holdings in United States, 1917–1925

[Thousand cases, i. e., 000 omitted]

Month	1917	1918	1919	1920	1921	1922	1923	1924	1925
January	920	1, 300	740	1, 542	408	889	1, 311	1, 927	1, 050
February	149	200	130	242	43	179	213	500	81
March	7	20	26	29	43	13	13	44	21
April	190	344	320	122	1, 926	950	453	579	1, 240
May	2, 105	2, 957	3, 278	2, 135	4, 909	4, 648	3, 737	3, 563	4, 872
June	4, 922	5, 499	6, 098	5, 143	6, 844	8, 056	7, 890	6, 875	7, 712
July	6, 617	6, 554	7, 659	6, 747	7, 534	9, 811	10, 222	8, 685	9, 482
August	6, 895	6, 568	7, 850	6, 872	7, 605	10, 161	10, 509	9, 267	10, 024
September	6, 436	6, 265	7, 685	6, 372	7, 210	9, 608	9, 883	8, 778	9, 873
October	5, 837	5, 369	6, 858	5, 295	6, 269	7, 924	8, 737	7, 416	8, 612
November	4, 638	3, 812	5, 087	5, 838	4, 380	5, 726	6. 645	5, 267	6, 322
December	2, 948	2, 071	3, 341	1, 824	2, 403	3, 257	4, 028	3, 103	3, 786

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Eggs: Monthly receipts at Boston, New York, Philadelphia, Chicago, and San Francisco, 1917–1925

[Thousand cases, i. e., 000 omitted]

Month	1917 [1]	1918 [2]	1919	1920	1921	1922	1923	1924	1925
Jan	367	298	494	508	653	809	852	714	618
Feb	376	324	1,014	815	1,161	1,025	1,032	1,006	1,176
Mar	1,046	1,511	1,556	1,447	2,209	1,952	2,118	1,654	1,846
Apr	2,017	2,501	2,761	1,934	2,467	2,902	2,268	2,539	2,563
May	2,348	2,185	2,425	2,203	2,055	2,583	2,852	2,544	2,193
June	1,734	1,690	1,890	1,805	1,561	1,926	2,066	1,871	2,025
July	1,186	1,378	1,276	1,143	1,142	1,304	1,349	1,431	1,315
Aug	919	1,175	1,018	911	1,107	1,019	1,180	1,042	1,106
Sept	813	898	826	806	909	816	988	876	930
Oct	696	763	691	594	727	704	844	748	709
Nov	433	442	394	398	488	484	555	457	433
Dec	319	400	341	382	531	492	587	524	626
Total	12,254	13,565	14,686	12,946	15,010	16,016	16,691	15,406	15,540

[1] Figures for 1917 do not include Philadelphia.
[2] Figures for 1918 do not include Philadelphia during January and February.

Prices

Average farm prices of important agricultural products, 1909–1925

Crop year [1]	Wheat [2]	Corn [3]	Oats [3]	Potatoes [3]	Cotton [3]
	Bushel	*Bushel*	*Bushel*	*Bushel*	*Pound*
Average 1909–1913	$0.888	$0.629	$0.396	$0.680	$0.122
1914–15	1.020	.724	.453	.583	.072
1915–16	.983	.690	.393	.668	.114
1916–17	1.508	1.212	.517	1.552	.177
1917–18	2.064	1.467	.709	1.264	.277
1918–19	2.078	1.521	.694	1.262	.282
1919–20	2.223	1.506	.785	2.037	.355
1920–21	1.845	.641	.538	1.370	.158
1921–22	1.029	.522	.335	1.226	.170
1922–23	.983	.756	.385	.726	.239
1923					
July 15	.896	.870	.402	1.029	.248
Aug. 15	.864	.870	.376	1.208	.238
Sept. 15	.910	.862	.380	1.096	.256
Oct. 15	.942	.848	.394	.914	.280
Nov. 15	.937	.783	.408	.825	.299
Dec. 15	.945	.722	.426	.815	.321

[1] For many farm products marketing takes place during portions of two calendar years, but for others the movement is wholly within the calendar year. In order that the movement and prices of the particular product may be followed through, the months in which the product moved have been used as the "crop year."
[3] Average price on 1st of each month up to December, 1923.

Average farm prices of important agricultural products, 1909–1925—Continued

Crop year [1]	Wheat	Corn	Oats	Potatoes	Cotton
1924	*Bushel*	*Bushel*	*Bushel*	*Bushel*	*Pound*
Jan. 15	$0.967	$0.736	$0.434	$0.864	$0.325
Feb. 15	.980	.765	.454	.881	.314
Mar. 15	.988	.772	.462	.878	.277
Apr. 15	.958	.782	.465	.911	.287
May 15	.968	.786	.463	.913	.281
June 15	.985	.808	.468	1.007	.278
July 15	1.058	.983	.494	1.090	.273
Aug. 15	1.168	1.074	.491	1.113	.278
Sept. 15	1.142	1.097	.471	.810	.222
Oct. 15	1.297	1.089	.489	.688	.231
Nov. 15	1.336	.996	.474	.635	.226
Dec. 15	1.411	1.056	.506	.641	.220
1925					
Jan. 15	1.621	1.120	.540	.702	.227
Feb. 15	1.698	1.145	.534	.723	.230
Mar. 15	1.640	1.121	.497	.714	.245
Apr. 15	1.405	1.038	.447	.705	.237
May 15	1.491	1.075	.454	.706	.230
June 15	1.527	1.110	.483	.844	.230
July 15	1.403	1.044	.453	1.255	.234
Aug. 15	1.504	1.065	.407	1.554	.234
Sept. 15	1.444	.988	.381	1.211	.225
Oct. 15	1.364	.830	.372	1.256	.215
Nov. 15	1.488	.746	.376	1.984	.181
Dec. 15	1.537	.707	.391	2.015	.174

Crop year [1]	Eggs [3]	Butter [3]	Hogs [3]	Beef cattle [3]	Lambs [3]
	Dozen	*Pound*	*Hundredweight*	*Hundredweight*	*Hundredweight*
Average 1909–13	[4] $0.190	[4] $0.252	[4] $7.01	[4] $5.24	[4] $5.75
1914–15	.193	.251	6.69	6.12	6.57
1915–16	.190	.257	7.61	6.24	7.49
1916–17	.233	.280	12.10	7.31	9.93
1917–18	.330	.359	15.78	8.92	13.84
1918–19	.349	.427	16.60	9.85	13.54
1919–20	.418	.503	13.43	9.09	12.94
1920–21	.393	.543	8.52	6.76	8.88
1921–22	.253	.370	8.10	5.18	8.06
1922–23	.247	.353	7.34	5.55	10.38

[1] For many farm products marketing takes place during portions of two calendar years, but for others the movement is wholly within the calendar year. In order that the movement and prices of the particular product may be followed through, the months in which the product moved have been used as the "crop year."

[3] Average price on 15th of each month.

[4] Average for 1910–1913.

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Average farm prices of important agricultural products, 1909–1925—Continued

Crop year [1]	Eggs [3]	Butter [3]	Hogs [3]	Beef cattle [3]	Lambs [3]
	Dozen	*Pound*	*Hundred weight*	*Hundred weight*	*Hundred weight*
1923					
July 15	$0.213	$0.370	$06.68	$05.72	$010.60
Aug. 15	.236	.380	6.85	5.60	9.96
Sept. 15	.298	.402	7.81	5.70	10.28
Oct. 15	.346	.422	7.23	5.48	10.17
Nov. 15	.456	.443	6.66	5.23	10.01
Dec. 15	.455	.458	6.39	5.26	10.10
1924					
Jan. 15	.354	.449	6.59	5.38	10.19
Feb. 15	.336	.444	6.54	5.47	10.53
Mar. 15	.204	.432	6.63	5.63	11.22
Apr. 15	.191	.403	6.70	5.82	11.32
May 15	.198	.383	6.68	5.94	11.43
June 15	.211	.363	6.55	5.79	11.21
July 15	.231	.370	6.60	5.65	10.50
Aug. 15	.261	.377	8.54	5.67	10.15
Sept. 15	.318	.382	8.50	5.53	10.18
Oct. 15	.382	.388	9.45	5.52	10.35
Nov. 15	.458	.393	8.62	5.43	10.55
Dec. 15	.499	.418	8.39	5.35	10.96
1925					
Jan. 15	.486	.413	9.31	5.63	12.69
Feb. 15	.357	.387	9.62	5.69	13.13
Mar. 15	.239	.395	11.83	6.18	13.48
Apr. 15	.242	.397	11.64	6.55	12.22
May 15	.248	.395	10.78	6.48	11.99
June 15	.261	.382	10.82	6.46	11.62
July 15	.279	.392	12.02	6.55	11.71
Aug. 15	.300	.400	12.19	6.58	11.80
Sept. 15	.311	.411	11.50	6.27	11.95
Oct. 15	.377	.442	11.16	6.31	12.04
Nov. 15	.468	.461	10.66	6.14	12.20
Dec. 15	.481	.460	10.51	6.18	12.67

[1] See footnote 1 on preceding page.
[3] Average price on 15th of each month.

Wool: Quarterly average price per pound on farms, by districts, 1914–1924

Date	Ohio, Pennsylvania, and West Virginia	Michigan, Wisconsin, and New York	Kentucky and Indiana	Missouri, Iowa, and Illinois	Texas	California	Montana, Wyoming, Utah, Idaho, Oregon, Nevada, Arizona	New Mexico	Florida, Alabama, Mississippi, Louisiana, Georgia
	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.
Av. 1914–1920	44	42	42	38	32	33	36	32	32
1921									
Jan.–Mar.	27	23	22	18	20	13	19	15	17
Apr.–June	22	19	17	17	15	10	16	14	16
July–Sept.	19	18	16	15	14	12	16	12	13
Oct.–Dec.	20	18	17	15	14	13	16	14	14
1922									
Jan.–Mar.	25	23	19	19	17	23	24	18	14
Apr.–June	33	29	27	25	26	31	31	26	18
July–Sept.	38	33	31	30	33	35	31	30	24
Oct.–Dec.	38	35	32	32	34	31	34	32	23
1923									
Jan.–Mar.	39	36	33	32	37	38	37	36	23
Apr.–June	43	42	40	39	40	42	42	40	27
July–Sept.	43	41	38	38	37	35	38	34	29
Oct.–Dec.	42	41	38	36	34	33	36	34	33
1924									
Jan.–Mar.	41	41	38	37	34	30	38	35	31
Apr.–June	42	40	38	36	38	35	38	32	30
July–Sept.	38	37	38	34	36	35	34	31	31
Oct.–Dec.	45	42	42	38	41	37	40	-----	32

Egg prices: Cents per dozen, for fresh firsts, New York City, 1920–1925

Month	1920	1921	1922	1923	1924	1925
January	71	67	41	42	42	59
February	59	42	38	37	39	44
March	48	31	25	31	25	30
April	44	27	26	27	24	29
May	44	25	27	27	25	32
June	43	27	25	24	27	33
July	47	33	24	25	29	33
August	51	35	26	29	33	33
September	57	39	39	35	39	37
October	64	49	43	39	44	43
November	77	58	53	53	52	56
December	78	54	53	47	57	51
Average	57	41	35	35	36	40

Source: Producers' Price Current.

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Butter prices: Cents per pound, 92 score, New York City, 1920–1925

Month	1920	1921	1922	1923	1924	1925
January	65.0	52.5	37.5	51.7	53.0	39.9
February	66.0	47.2	37.2	49.8	50.5	40.8
March	67.0	48.1	38.4	49.3	46.7	47.5
April	71.0	45.5	37.7	46.1	38.5	44.5
May	61.0	31.8	36.8	41.9	38.9	42.6
June	57.0	32.7	36.7	38.9	41.5	42.5
July	57.0	40.4	36.2	39.4	40.0	42.9
August	55.0	42.7	35.4	44.1	38.4	43.4
September	59.0	43.1	41.0	46.0	37.9	48.2
October	60.0	47.9	46.0	47.8	38.8	50.9
November	63.0	44.9	50.7	52.6	43.0	50.7
December	55.0	43.8	54.2	54.7	44.8	49.2
Average	61.0	43.3	40.6	46.9	42.7	45.3

Source: U. S. Bureau of Agricultural Economics.

Exports and Imports

Exports: Principal agricultural products exported from the United States, calendar years, 1923–1925

[Thousands, i. e., 000 omitted]

Article	Unit of quantity	Year ended Dec. 31—		
		1923	1924	1925 [1]
Cattle	Number	37	61	81
Hogs	do	88	83	46
Horses and mules	do	27	25	43
Sheep	do	17	19	12
Beef and veal, fresh	Pounds	3,386	2,628	3,359
Beef, pickled	do	23,042	21,923	20,930
Beef, canned	do	1,733	1,500	2,174
Pork, fresh	do	54,691	32,803	19,821
Pork, pickled	do	41,841	28,280	27,453
Pork, canned	do	2,801	3,274	4,702
Mutton, except canned	do	2,087	1,445	1,464
Sausage, not canned	do	7,937	8,565	7,963
Sausage, canned	do	2,798	3,532	3,773
Sausage, casings	do	17,214	39,967	36,578
Hams and shoulders	do	372,093	[1] 323,877	[2] 265,883
Bacon	do	456,797	[2] 314,103	[3] 201,575
Eggs in shell	Dozen	30,659	28,117	24,999
Milk, condensed, evaporated, and powdered.	Pounds	196,702	211,809	151,412

[1] Preliminary.
[2] Including Wiltshire sides.
[3] Including Cumberland sides.

Exports: Principal agricultural products exported from the United States, calendar years, 1923–1925—Continued

[Thousands, i. e., 000 omitted]

Article	Unit of quantity	Year ended Dec. 31— 1923	1924	1925[1]
Butter	Pounds	5,846	8,257	5,343
Cheese	do	8,331	4,299	9,190
Oleo oil	do	98,955	99,380	91,791
Oleo stock	do	10,301	13,797	12,174
Oleomargarine containing animal fats.	do	1,792	774	627
Tallow, edible and inedible.	do	35,129	33,962	17,514
Lard	do	1,036,382	944,095	688,829
Neutral lard	do	24,129	27,365	18,854
Lard compounds containing animal fats.	do	7,451	7,382	14,091
Cattle hides	do	23,853	79,706	49,926
Calfskins	do	3,982	11,191	12,941
Sheep and goat skins	do	1,015	2,821	2,783
Barley	Bushels	11,983	20,712	29,089
Corn	do	42,188	18,366	12,762
Oats	do	3,227	3,953	29,443
Rice[4]	Pounds	348,839	154,509	65,923
Rye	Bushels	30,850	35,666	28,675
Wheat	do	98,533	166,302	86,526
Wheat flour	Barrels	16,310	15,990	11,119
Oil cake and oil-cake meal	Pounds	917,394	1,289,948	1,487,756
Potatoes	Bushels	2,696	3,862	2,323
Oranges	Boxes	2,294	2,564	1,981
Apples in boxes	do	4,671	6,719	4,922
Apples in barrels	Barrels	1,402	1,881	1,707
Apples, dried	Pounds	16,708	29,740	22,721
Raisins	do	77,814	92,140	125,924
Apricots, dried	do	20,169	30,456	20,161
Peaches, dried	do	4,656	12,552	4,412
Prunes, dried	do	59,104	220,912	146,485
Peanuts	do	4,806	3,127	3,489
Coconut oil	do	16,562	17,961	17,901
Cottonseed oil	Gallons	6,614	5,779	8,322
Corn oil	Pounds	4,361	3,679	3,847
Seeds for sowing	do	33,383	29,604	26,664
Sugar, including maple	do	444,916	440,495	758,716
Glucose (corn sirup)	do	136,600	171,722	146,068
Tobacco leaf[5]	do	474,500	546,555	468,456
Hops	do	20,041	17,391	20,655
Cotton, raw (500-pound bales).	Bales	5,543	6,965	8,768
Starch, corn and other	Pounds	204,235	270,383	232,749

[1] Preliminary.
[4] Includes flour, meal, and broken rice.
[5] Excludes "stems, trimmings, and scrap."

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Imports: Principal agricultural products imported into the United States, calendar years, 1923–1925

[Thousands, i. e., 000 omitted]

Article	Unit of quantity	Year ended Dec. 31— 1923	1924	1925 [1]
Cattle	No.	140	144	174
Horses	do.	3	3	2
Sheep	do.	39	30	67
Butter	Lbs.	23,741	19,405	7,212
Cheese	do.	64,420	59,176	62,403
Milk and cream	Galls.	7,558	9,390	12,594
Milk, condensed, evaporated, etc.	Lbs.	10,398	8,489	12,394
Eggs	Doz.	412	383	609
Eggs and egg yolks, preserved.	Lbs.	16,253	15,958	25,470
Wool, carpet	do.	122,399	140,960	157,971
Wool, clothing	do.	30,851	17,785	23,578
Wool, combing	do.	235,095	103,910	155,197
Hair—Angora, goat, alpaca, Mohair, etc.	do.	5,906	5,558	2,607
Bones, hoofs, and horns, unmounted.	do.	115,353	100,200	95,742
Calf and kip skins, dry and wet.	do.	48,698	41,112	28,812
Cattle hides, dry and wet	do.	291,969	185,614	166,748
Goat and kid skins, dry and wet.	do.	85,853	52,234	81,648
Horse, colt, ass, etc. hides, dry and wet.	do.	16,204	10,489	12,030
Sheep and lamb skins, dry and wet.	do.	53,041	58,047	61,551
Beef and veal, fresh	do.	19,356	18,104	15,870
Mutton and lamb, fresh	do.	5,215	2,166	2,770
Sausage casings	do.	19,854	18,639	19,517
Corn	Bush.	203	4,107	1,086
Oats	do.	317	6,964	178
Rice (in terms of cleaned rice).[2]	Lbs.	48,520	40,737	68,466
Wheat	Bush.	19,502	15,534	13,903
Wheat flour	Bbls.	268	65	11
Oil cake and oil-cake meal.	Lbs.	124,124	154,572	88,535
Coffee	do.	1,409,755	1,420,870	1,283,601
Cotton, raw (478 pounds per bale).	Bales	392	336	328
Tanning extracts (quebracho and other).	Lbs.	141,534	99,649	117,165
Currants	do.	23,473	13,965	14,192
Dates	do.	41,733	63,607	78,706
Figs	do.	32,433	42,485	46,572
Raisins and other dried grapes.	do.	9,848	7,594	7,938

[1] Preliminary.
[2] 1.62 pounds rough rice or paddy equals 1 pound cleaned rice.

Imports: Principal agricultural products imported from the United States, calendar years, 1923–1925—Continued

[Thousands, i. e., 000 omitted]

Article	Unit of quantity	Year ended Dec. 31—		
		1923	1924	1925 [1]
Almonds, not shelled	Lbs	2,635	3,250	4,152
Almonds, shelled	do	25,893	22,204	16,144
Coconuts, in the shell	No	66,543	57,271	59,871
Coconut meat (broken or copra) shredded, desiccated, or prepared.	Lbs	45,526	47,302	47,090
Cream or Brazil nuts	do	32,455	53,183	21,864
Filberts, not shelled	do	15,584	9,121	10,378
Filberts, shelled	do	6,814	5,924	4,197
Chestnuts (including marrons).	do	25,199	27,338	25,710
Peanuts, not shelled [3]	do	76,484	88,915	120,158
Walnuts, not shelled	do	18,309	25,101	28,006
Walnuts, shelled	do	18,246	19,198	23,756
Coconut oil	do	181,882	224,763	233,174
Linseed or flaxseed oil	do	43,097	13,247	13,607
Olive oil, edible	do	77,190	76,186	90,426
Copra or dried coconut (not prepared).	do	332,974	291,064	364,076
Castor-beans or suds	do	88,539	84,977	107,232
Flaxseed	Bush	24,332	16,589	16,510
Clover seed (red and other).	Lbs	28,608	42,965	36,161
Sugar, cane and beet	do	7,709,337	8,275,746	8,933,233
Tea	do	105,138	92,773	100,962
Tobacco leaf (unmanufactured).[4]	do	55,314	66,721	75,920
Beans, dried [5]	Bush	2,076	1,135	1,445
Peas, dried [5]	do	311	414	400
Casein or lactarine	Lbs	26,094	17,750	18,804

[1] Preliminary.
[3] 1.5 pounds unshelled peanuts equals 1 pound shelled.
[4] Excludes "scrap, stems, and trimmings."
[5] Reduced to bushels on the basis of 60 pounds equals 1 bushel.

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Imports: Origin of principal farm products imported into the United States, years ended June 30, 1923–1925

Article and country of origin	1922–23	1923–24	1924–25 [1]	Per cent of total imports		
				1922–1923	1923–1924	1924–1925[1]
Cattle:	*Number*	*Number*	*Number*			
Canada	230, 227	141, 171	121, 802	91. 4	91. 2	89. 7
Mexico	20, 301	12, 853	13, 326	8. 1	8. 3	9. 8
Horses:						
Canada	2, 165	1, 900	1, 571	76. 9	77. 3	73. 3
United Kingdom	310	419	374	11. 0	17. 0	17. 5
Butter:	*Pounds*	*Pounds*	*Pounds*			
Denmark	7, 371, 147	10, 457, 458	839, 629	46. 7	35. 5	11. 7
Canada	2, 989, 355	6, 451, 170	3, 587, 770	19. 0	21. 9	49. 9
New Zealand	3, 887, 174	5, 047, 654	1, 985, 496	24. 6	17. 1	27. 6
Cheese:						
Italy	20, 571, 704	32, 922, 074	32, 842, 899	37. 7	49. 4	53. 4
Switzerland	14, 765, 121	16, 140, 224	15, 222, 229	27. 1	24. 2	24. 8
Canada	5, 858, 305	1, 803, 217	535, 349	10. 7	2. 7	. 9
Silk, raw:						
Japan	37, 989, 046	34, 445, 020	46, 855, 276	72. 1	74. 6	79. 2
China	10, 584, 948	8, 718, 404	8, 757, 498	20. 1	18. 9	14. 8
Wool, unmanufactured; carpet wool:						
China	65, 140, 551	57, 718, 076	56, 590, 990	37. 9	48. 8	40. 9
United Kingdom	60, 859, 099	29, 396, 237	45, 521, 281	35. 4	24. 8	32. 9
Argentina	8, 695, 254	7, 758, 910	4, 592, 577	5. 1	6. 6	3. 3
Clothing wool:						
United Kingdom	15, 407, 663	4, 236, 568	6, 882, 070	35. 3	33. 0	28. 2
Argentina	9, 762, 858	3, 101, 080	7, 636, 574	22. 3	24. 2	31. 2
Australia	5, 195, 722	1, 104, 650	1, 755, 787	11. 9	8. 6	7. 2
Wool, combing:						
Argentina	77, 256, 141	19, 787, 998	18, 911, 034	25. 9	19. 2	16. 0
Australia	69, 406, 989	33, 180, 931	37, 101, 110	23. 3	32. 2	31. 5
United Kingdom	58, 657, 619	23, 751, 430	19, 527, 037	19. 7	23. 1	16. 6
Hair of Angora goat, alpaca, etc.:						
United Kingdom	4, 674, 695	1, 852, 429	1, 083, 648	41. 0	37. 6	28. 4
British South Africa	3, 469, 041	715, 621	1, 126, 932	30. 5	14. 5	29. 6
Turkey in Europe	2, 601, 398	1, 255, 881	225, 137	22. 8	25. 5	5. 9
Calfskins, dry:						
Argentina	4, 474, 240	1, 673, 587	997, 043	29. 9	15. 6	12. 3
Canada	1, 224, 488	735, 369	486, 943	8. 2	6. 8	6. 0
France	1, 519, 034	198, 582	308, 076	10. 1	1. 8	3. 8
Calfskins, wet:						
France	8, 833, 727	3, 395, 954	3, 937, 049	28. 7	18. 4	17. 0
Canada	5, 068, 156	5, 412, 337	5, 519, 284	16. 5	29. 3	23. 9
Sweden	3, 065, 676	1, 295, 525	2, 279, 794	10. 0	7. 0	9. 9

[1] Preliminary.

Imports: Origin of principal farm products imported into the United States, years ended June 30, 1923–1925—Continued

Article and country of origin	1922–23	1923–24	1924–25 [1]	Per cent of total imports		
				1922–1923	1923–1924	1924–1925[1]
Cattle hides, dry:	*Number*	*Number*	*Number*			
Argentina	17,719,184	2,509,740	2,040,226	30.1	13.9	14.2
Colombia	7,865,138	6,271,063	5,293,983	13.4	34.6	36.8
China	6,905,068	1,028,209	52,694	11.7	5.7	2.4
Cattle hides, wet:						
Argentina	186,696,992	99,660,875	113,565,163	53.9	62.9	61.4
Canada	30,489,525	28,602,925	36,084,396	8.8	18.1	19.5
Uruguay	34,551,249	11,714,089	8,614,600	10.0	7.4	4.7
Goat and kid skins, dry:						
British India	19,597,086	13,173,680	17,190,066	28.0	25.4	30.1
China	12,148,704	8,636,578	8,467,982	17.2	16.7	14.8
Argentina	4,843,644	3,130,925	3,668,173	6.8	6.0	6.4
Goatskins, wet:						
British India	16,824,162	12,989,559	7,410,757	90.4	92.3	84.7
Sheep and lamb skins, dry and wet:						
Argentina	16,229,412	12,442,382	10,531,498	18.8	20.2	16.9
New Zealand	13,666,790	12,917,279	16,638,910	15.8	21.0	26.7
United Kingdom	27,358,807	12,700,231	13,421,187	31.7	20.7	21.5
India rubber, crude:						
British East Indies	547,799,814	416,837,321	506,103,995	68.7	67.5	63.1
Dutch East Indies	113,302,153	115,233,963	147,319,412	14.2	18.7	18.3
Cocoa or cacao beans:						
British West Africa	122,276,584	152,532,542	138,513,157	32.1	39.8	36.2
Brazil	59,978,071	71,736,843	71,816,467	15.7	18.7	18.8
Dominican Republic	42,457,894	42,368,024	46,926,416	11.1	11.1	12.3
Coffee:						
Brazil	840,038,490	950,950,167	860,269,172	64.4	66.5	67.2
Colombia	193,889,565	254,381,159	223,169,914	14.9	17.8	17.4
Cotton, raw:						
Egypt	157,990,018	78,631,055	91,930,193	66.9	53.8	59.3
China	24,792,329	21,577,342	15,941,770	10.5	14.8	10.3
Mexico	15,868,478	13,442,658	22,287,221	6.7	9.2	14.4
Flax:						
United Kingdom	*Tons* 2,661	*Tons* 1,699	*Tons* 1,595	32.4	34.8	37.0
Canada	2,091	1,292	499	25.5	26.4	11.6
Manila fiber:						
Philippine Islands	96,758	97,261	72,402	99.1	99.2	99.3
Sisal grass:						
Mexico	77,383	71,162	116,374	79.3	73.4	79.7
Dutch East Indies	8,932	11,172	13,742	9.2	11.5	9.4

[1] Preliminary.

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Imports: Origin of principal farm products imported into the United States, years ended June 30, 1923–1925—Continued

Article and country of origin	1922-23	1923-24	1924-25[1]	Per cent of total imports 1922-1923	1923-1924	1924-1925[1]
Rice, cleaned:	*Pounds*	*Pounds*	*Pounds*			
Hongkong	21,054,035	21,266,678	24,941,943	37.0	66.1	59.9
French Indo-China	27,773,526	1,770,000	417,500	48.8	5.5	1.0
Wheat:	*Bushels*	*Bushels*	*Bushels*			
Canada	18,012,467	27,276,774	6,169,024	100.0	100.0	100.0
Wheat flour:	*Barrels*	*Barrels*	*Barrels*			
Canada	428,659	168,799	6,219	99.8	99.8	92.6
Filberts, shelled:	*Pounds*	*Pounds*	*Pounds*			
Spain	4,672,896	3,017,454	2,197,158	75.3	41.0	50.6
Turkey in Europe	654,527	2,065,648	774,966	10.5	28.1	17.8
Filberts, not shelled:						
Italy	13,911,108	14,037,698	7,184,872	96.8	99.5	77.0
Peanuts, shelled:						
China	28,350,727	42,043,532	83,786,251	66.8	87.0	97.9
Japan	12,102,549	2,358,318	466,018	28.5	4.9	.5
Peanuts, not shelled:						
China	2,462,095	3,055,120	9,357,234	63.7	85.8	82.3
Japan	999,204	409,590	1,543,498	25.9	11.5	13.6
Walnuts, shelled:						
France	13,846,640	15,233,834	17,050,910	78.6	81.2	72.1
China	1,676,430	1,756,451	3,424,349	9.5	9.4	14.5
Walnuts, not shelled:						
Italy	8,497,492	10,389,368	11,477,343	42.7	56.9	37.1
France	8,487,674	4,622,757	9,222,391	42.6	25.3	29.8
Coconut oil:						
Philippine Islands	210,968,211	181,013,122	250,120,748	99.2	99.9	99.9
Olive oil, edible:						
Italy	43,935,892	52,076,274	58,380,487	58.9	64.4	72.7
Spain	18,213,291	19,560,602	11,323,964	24.4	24.2	14.1
Soybean oil:						
Kwangtung	31,621,507	16,034,460	15,491,975	81.8	90.9	75.8
China	2,105,590	1,534,950	3,431,070	5.4	8.7	16.8
Flaxseed:	*Bushels*	*Bushels*	*Bushels*			
Argentina	22,330,931	16,169,352	8,255,176	89.3	82.6	61.5
Canada	2,191,103	3,365,498	5,137,183	8.8	17.2	38.3
Clover seed, red:						
France	245,766	17,094,803	4,842,935	40.4	70.4	74.6
Germany	52,848	733,345	519,201	8.7	3.0	8.0
Sugar, raw cane:	*Tons*	*Tons*	*Tons*			
Cuba	4,020,796	3,257,632	3,858,186	92.1	86.5	89.0

[1] Preliminary.

Imports: Origin of principal farm products imported into the United States, years ended June 30, 1923–1925—Continued

Article and county of origin	1922–23	1923–24	1924–25[1]	Per cent of total imports		
				1922–1923	1923–1924	1924–1925[1]
Tobacco leaf:	*Pounds*	*Pounds*	*Pounds*			
Cuba	22, 548, 257	18, 297, 557	20, 859, 921	30. 5	34. 9	27. 8
Greece	27, 869, 579	12, 887, 544	27, 724, 885	37. 7	24. 6	36. 9
Netherlands	9, 696, 482	6, 327, 453	5, 611, 529	13. 1	12. 1	7. 5
Tea:						
Japan	35, 974, 918	34, 297, 049	28, 529, 302	37. 2	32. 5	30. 7
British East Indies	19, 851, 220	23, 720, 914	24, 784, 514	20. 5	22. 5	26. 7
China	13, 507, 750	18, 538, 792	10, 321, 852	14. 0	17. 6	11. 1
Pepper, unground:						
Dutch East Indies	18, 594, 560	21, 793, 822	27, 297, 296	55. 5	79. 8	72. 8
British India	6, 900, 406	1, 310, 831	3, 496, 047	20. 6	4. 8	9. 3
Straits Settlements	5, 130, 284	3, 073, 238	4, 249, 780	15. 3	11. 2	11. 3

[1] Preliminary.

Exports: Destination of the major proportion of principal farm products exported from the United States, years ending June 30, 1923–1925

Article and country to which consigned	1922–23	1923–24	1924–25[1]	Percentage of total exports		
				1922–23	1923–24	1924–25[1]
Cattle:	*Number*	*Number*	*Number*			
Mexico	49, 223	26, 006	99, 375	80. 1	79. 4	94. 1
Cuba	2, 529	3, 046	3, 214	4. 1	9. 3	3. 0
Horses:						
Canada	2, 496	1, 754	1, 727	28. 9	15. 0	15. 9
Mexico	3, 802	7, 579	5, 375	44. 0	64. 8	49. 4
Beef, canned:						
United Kingdom	*Pounds* 722, 441	*Pounds* 303, 680	*Pounds* 691, 917	31. 2	19. 7	37. 7
Germany	52, 192	387, 733	29, 064	2. 3	25. 1	1. 6
Beef, pickled and other cured:						
Newfoundland and Labrador	6, 627, 439	7, 420, 262	7, 841, 130	27. 4	34. 0	35. 0
United Kingdom	3, 084, 799	1, 667, 457	1, 944, 258	12. 8	7. 6	8. 7
Norway	1, 785, 320	1, 105, 581	1, 264, 410	7. 4	5. 1	5. 6

[1] Preliminary.

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Exports: Destination of the major proportion of principal farm products exported from the United States, years ending June 30, 1923–1925—Continued

Article and country to which consigned	1922-23	1923-24	1924-25[1]	Percentage of total exports		
				1922-23	1923-24	1924-25[1]
Bacon:						
United Kingdom	*Number* 188,274,240	*Number* 146,232,728	*Number* 104,627,031	46.1	35.8	49.4
Germany	74,441,278	80,226,029	25,972,307	18.2	19.6	12.3
Ham and shoulders:						
United Kingdom	259,352,777	297,751,898	229,124,536	81.2	80.4	82.6
Belgium	13,978,797	21,159.400	13,399,710	4.4	5.7	4.8
Canada	19,535,776	15,111,834	5,601,147	6.1	4.1	2.0
Pork, pickled:						
Canada	13,348,745	8,436,629	5,391,594	32.6	22.5	20.2
Newfoundland and Labrador	5,265,840	5,154,915	4,206,344	12.9	13.8	15.7
United Kingdom	5,852,630	4,105,706	3,280,555	14.3	11.0	12.3
Lard:						
Germany	328,111,752	329,792,983	251,982,930	34.4	32.5	31.8
United Kingdom	241,144,099	240,016,876	223,010,931	25.3	23.7	28.1
Cotton, including linters:						
France	352,099,567	375,712,020	475,736,688	13.4	12.7	11.3
Germany	472,823,551	672,777,063	945,995,969	18.0	22.8	22.4
Japan	339,579,297	291,978,531	424,792,136	12.9	9.9	10.1
United Kingdom	701,503,949	847,447,334	1,311,712,576	26.7	28.7	31.1
Cottonseed oil:						
Canada	26,549,253	20,516,191	23,714,362	41.3	52.0	44.5
Mexico	6,711,448	8,376,445	3,808,649	10.4	21.3	7.2
Cottonseed cake:						
Denmark	195,357,016	150,179,071	434,529,943	57.0	74.7	73.2
Germany	132,347,594	39,142,550	100,910,828	38.6	19.5	17.0
Linseed cake:						
Netherlands	351,445,009	361,799,262	395,438,820	65.5	66.2	58.9
Belgium	91,655,770	86,467,843	187,903,965	17.1	15.8	28.0
Corn:	*Bushels*	*Bushels*	*Bushels*			
Canada	32,153,890	8,257,917	4,239,042	34.2	39.0	50.1
United Kingdom	21,271,080	4,448,973	140,835	22.6	21.0	1.7
Germany	11,806,514	672,586	26,317	12.6	3.2	.3
Wheat:						
United Kingdom	28,237,471	16,811,144	40,274,402	18.2	21.3	20.6
Italy	33,771,801	7,814,642	25,726,795	21.8	9.9	13.2
Canada	31,992,628	17,979,540	55,596,684	20.6	22.8	28.4
Germany	8,492,567	1,919,085	7,960,326	5.5	2.4	4.1

[1] Preliminary.

Exports: Destination of the major proportion of principal farm products exported from the United States, years ending June 30, 1923–1925—Continued

Article and country to which consigned	1922–23	1923–24	1924–25 [1]	Percentage of total exports		
				1922–23	1923–24	1924–25 [1]
Wheat flour:						
United Kingdom	*Barrels* 1,913,833	*Barrels* 1,451,452	*Barrels* 2,105,234	12.9	8.4	15.1
Germany	1,062,684	1,488,329	1,995,118	7.1	8.6	14.4
Netherlands	982,736	1,841,398	1,781,479	6.6	10.7	12.8
Cuba	1,088,582	1,114,160	1,232,649	7.3	6.5	8.9
Tobacco, leaf:						
United Kingdom	*Pounds* 152,700,297	*Pounds* 161,237,383	*Pounds* 140,772,423	34.3	28.9	33.5
China	39,792,536	66,017,078	53,932,515	8.9	11.8	12.8
Germany	30,681,022	55,667,010	19,726,377	6.9	10.0	4.7
Italy	42,400,610	25,206,503	9,421,120	9.5	4.5	2.3
Potatoes:	*Bushels*	*Bushels*	*Bushels*			
Cuba	1,921,631	1,931,518	1,869,415	64.5	62.8	51.2
Canada	414,487	536,653	1,038,407	13.9	17.5	28.4
Hops:						
United Kingdom	*Pounds* 2,351,919	*Pounds* 8,341,301	*Pounds* 5,758,018	17.4	40.8	35.7
Canada	3,031,538	3,142,801	3,318,211	22.5	15.4	20.6

[1] Preliminary.

Duties

Duties imposed by the tariff of 1922

DUTIES ON ARTICLES FOR FARM CONSUMPTION

Article	Tariff	Article	Tariff
Farm machinery:		Fertilizer	Free, except sulphate of ammonia.
Cream separators.	Under $50 value, free.	Harness	Double, value over $70, 35%; single, value over $40, 35%; other, free.
Plows and cultivators.	Free.		
Threshing machines.	Free.		
All other	Free.[1]		
Barbed wire	Free.		
Binder twine	Free.		
Wire fencing	½¢ per lb.		

[1] Scythes, sickles, and corn knives, 30 per cent.

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Duties imposed by the tariff of 1922—Continued

DUTIES ON ARTICLES FOR GENERAL CONSUMPTION

Article	Tariff	Article	Tariff
Autos and chasses	25%.	Steel wire—Con.	
Beef and veal	3¢ per lb.	Galvanized	$\frac{2}{10}$¢ in addition.
Building brick	Free.		
Cement	Free.	Cane sugar	Testing not over 75°, 1.24¢ per lb., each added degree 0.46¢ per lb.
Coal	Free.[2]		
Coffee	Free.		
Cotton goods:			
Socks	30 to 50%.		
Shirts	35%.		
Overalls	35%.		
Blankets	25%.	Flour, wheat	78¢ per cwt.
Sheets	25%.	Wood:	
Gasoline and similar products.	Free.	Shingles	Free.
		Lumber, sawed or planed on one side.	Free.
House furniture	33⅓%.		
Leather, shoes, slippers, etc.	Free.	Board and planks.	15%.
Mutton	2½¢ per lb.		
Lubricating oil	Free.	Woolen:	
Paints, stains, and enamels	25%.	Suits	24¢ per lb. and 45% to 45¢ per lb. and 50%.
Pork	¾¢ per lb.		
Steel wire:			
Round	¾¢ per lb. not smaller than $\frac{95}{1000}$ in.	Blankets	18–37¢ and 30 to 40%.
		Carpets	25–30%.

DUTIES ON AGRICULTURAL IMPORTS

Article	Tariff	Article	Tariff
Barley	20¢ per bush.	Horses	Value, $150 per head, $30; over $150, per head, 20%.
Butter and substitutes.	8¢ per lb.		
Cattle	0–1,050 lbs., 1½¢ per lb.; 1,050 lbs. and over, 2¢ per lb.	Oats	15¢ per bush.
		Potatoes	50¢ per cwt.
		Rice	Cleaned, 2¢ per lb.
		Rye	15¢ per bush.
Cheese and substitutes.	5¢ per lb.	Sheep	$2 per head.
		Tobacco	Filler, 35¢–50¢ per lb.
Corn	15¢ per bush.		
Cotton	Free.	Wheat	30¢ per bush.[3]
Eggs	8¢ per doz.	Wool	11¢, 12¢, 18¢, and 24¢ per lb.
Flaxseed	40¢ per bush.		
Hogs	1¢ per lb.		

[2] Except when from a country having a duty on American coal.

[3] Changed Mar. 7, 1924, by presidential proclamation. Present duty is $1.04 per 100 pounds of flour and 42 cents per bushel of wheat.

Miscellaneous

Index numbers of farm prices and wholesale prices of nonagricultural commodities, 1910–1925

Year and month	Index numbers of farm prices — August, 1909–July, 1914=100: Grains	Fruits and vegetables	Meat animals	Dairy and poultry products	Cotton and cottonseed	All groups	Wholesale prices of nonagricultural commodities[1] (1910-1914=100)	Purchasing power of farm products[2]
1910	104	91	103	101	113	103	102	101
1911	96	106	87	95	101	95	96	99
1912	106	110	95	103	87	99	100	99
1913	92	92	108	100	97	100	105	95
1914	103	100	112	101	85	102	97	105
1915	120	83	104	99	78	100	101	99
1916	126	123	120	106	119	117	138	85
1917	217	202	173	133	187	176	182	97
1918	226	162	202	160	245	200	188	106
1919	231	189	206	182	247	209	199	105
1920	231	249	173	197	248	205	241	85
1921	112	148	108	151	101	116	167	69
1922	105	152	113	135	156	124	168	74
1923	114	136	106	147	216	135	171	79
1924	129	124	109	137	211	134	162	83
1925	156	160	139	143	177	147	165	89
1923								
January	113	117	110	157	203	134	177	76
February	114	122	110	151	215	136	178	76
March	117	130	110	144	224	136	179	76
April	121	146	110	139	222	137	180	76
May	123	157	108	136	211	135	176	77
June	119	161	103	135	207	133	172	77
July	112	165	105	133	199	130	169	77
August	109	151	104	138	190	128	167	77
September	111	131	112	144	204	132	167	79
October	113	123	106	156	221	134	165	81
November	110	114	100	166	238	136	163	83
December	108	114	98	166	253	137	162	85

[1] Bureau of Labor Statistics, index of wholesale prices of all commodities other than those originating on United States farms. Those originating on farms not included here are: (1) The farm-products group, excepting hides and skins; (2) the food group excepting cocoa beans, coffee, copra, fish, pepper, salt, tea, and coconut oil; and (3) cattle feed, including bran, cottonseed meal, linseed meal, and mill-feed middlings.

[2] The ratio of farm prices to wholesale prices of nonagricultural commodities.

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Index numbers of farm prices and wholesale prices of nonagricultural commodities, 1910–1925—Con.

Year and month	Index numbers of farm prices, August, 1909–July, 1914=100: Grains	Fruits and vegetables	Meat animals	Dairy and poultry products	Cotton and cottonseed	All groups	Wholesale prices of nonagricultural commodities[1] (1910–1914=100)	Purchasing power of farm products[2]
1924								
January	110	118	101	155	255	137	164	84
February	113	123	102	152	247	136	166	82
March	114	123	104	136	219	131	166	79
April	113	128	106	126	226	130	164	79
May	114	132	107	123	222	129	162	80
June	116	146	105	123	219	130	159	82
July	130	142	103	122	215	132	158	84
August	141	138	116	123	219	139	159	87
September	140	113	115	133	175	132	158	84
October	150	109	121	142	182	138	158	87
November	147	108	115	150	179	137	160	86
December	155	110	113	158	176	139	163	85
1925								
January	172	122	123	154	182	146	165	88
February	178	131	126	142	183	146	167	88
March	172	138	145	134	195	151	165	91
April	152	146	146	131	189	147	162	90
May	159	162	139	132	184	146	161	90
June	164	184	139	132	183	148	163	91
July	152	178	148	134	186	149	164	91
August	157	178	149	139	186	152	164	93
September	148	142	143	141	178	144	163	88
October	135	152	141	154	171	143	164	87
November	138	194	136	162	144	144	166	87
December	140	194	136	163	139	143	165	87

[1] See footnote 1 on preceding page.
[2] The ratio of farm prices to wholesale prices of nonagricultural commodities.

Index numbers showing changes in freight rates of 50 representative agricultural products, by months, 1914–1925

[Average for year 1913=100]

Month	1914	1915	1916	1917	1918	1919
January	99.3	99.7	100.6	100.7	102.4	130.3
February	99.4	100.0	100.6	100.7	102.4	130.3
March	99.4	100.2	100.6	100.8	102.4	130.4
April	99.4	100.2	100.6	100.8	103.2	130.5
May	99.4	100.3	100.6	100.8	103.3	130.5
June	99.4	100.3	100.6	100.8	108.8	130.8
July	99.4	100.3	100.6	100.8	130.7	130.8
August	99.4	100.3	100.6	101.6	130.7	130.5
September	99.4	100.3	100.7	101.9	130.7	130.7
October	99.4	100.5	100.7	102.2	130.5	131.4
November	99.5	100.4	100.7	102.4	130.3	131.4
December	99.6	100.4	100.7	102.4	130.3	131.6
Average	99.4	100.2	100.6	101.3	117.1	130.8

Month	1920	1921	1922	1923	1924	1925
January	131.8	176.8	160.5	157.9	157.9	157.5
February	131.8	176.8	160.5	157.9	157.9	157.5
March	132.1	177.3	160.5	157.9	157.9	157.5
April	132.1	177.8	160.7	157.9	157.9	157.5
May	132.1	177.8	160.3	157.9	157.9	157.5
June	131.9	177.8	159.4	157.9	157.9	157.5
July	131.7	177.7	157.2	157.9	157.7	157.5
August	140.2	177.4	157.2	157.9	157.5	157.5
September	176.1	177.2	157.5	157.9	157.5	157.5
October	176.1	176.1	157.9	157.9	157.5	157.5
November	176.1	175.8	157.9	157.9	157.5	157.5
December	176.3	175.8	157.9	157.9	157.5	157.5
Average	147.4	177.0	159.0	157.9	157.7	157.5

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Index numbers of Chicago prices to dealers for representative farm implements, 1913–1923 [1]

Implement	1913	1916	1917	1918	1919	1920	1921	1922	1923
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Group of 13 representative farm implements [2]	100	110	131	178	188	196	185	152	154
Grain binder (6-foot with bundle carrier)	100	105	126	174	174	164	171	145	145
Grain drill (12 by 7, single disk)	100	102	126	169	169	169	173	147	146
Corn planter (with 80 rods wire)	100	107	135	176	176	176	173	156	157
Corn binder (with bundle carrier)	100	105	126	174	174	164	171	145	145
Mowers (5-foot, plain lift)	100	108	132	184	184	176	186	159	159

[1] F. o. b.

[2] The group includes each one of the following implements: Grain binder, mower, self-dump hay rake, hay loader, corn planter, corn binder, silage cutter, grain drill, disk harrow, spring-tooth harrow, spike-tooth harrow, cream separator, standard 3¼-inch wagon.

Index numbers of agricultural exports, 1910–1924

[Base, July, 1909–June, 1914=100]

Year ended June 30	All commodities	All commodities excluding cotton	Grains and products	Cattle and meat products	Dairy products	Fruits and vegetables
1910	78	86	82	91	58	77
1911	92	92	85	104	93	92
1912	114	100	78	115	126	100
1913	110	119	143	97	120	134
1914	106	103	112	92	103	98
1915	138	189	301	126	302	133
1916	118	184	237	164	479	134
1917	118	182	217	164	716	127
1918	101	165	179	197	975	87
1919	144	255	272	287	1, 287	177
1920	134	207	218	185	1, 275	153
1921	127	212	329	154	524	137
1922	137	218	317	153	571	118
1923	112	182	246	169	406	129
1924	104	153	143	179	451	213
1925	126	167	225	140	396	186

PRODUCTION

Farm Labor

Average length of work day of hired labor, by States. Estimates based upon reports of crop correspondents, United States Department of Agriculture

State	Spring		Summer		Fall		Winter		Average, four seasons	
	Hours	Minutes	Hours	Minutes	Hours	Minutes	Hours	Minutes	Hours	Minutes
Maine	9	50	10	20	9	35	8	40	9	39
New Hampshire	9	55	10	----	9	50	9	10	9	44
Vermont	10	15	10	40	10	5	9	15	9	45
Massachusetts	9	45	10	----	9	40	8	55	9	35
Rhode Island	9	40	10	10	10	----	8	50	9	40
Connecticut	9	50	10	30	9	40	8	55	9	44
New York	10	5	10	30	9	50	8	35	9	45
New Jersey	10	----	10	15	9	35	8	40	9	37
Pennsylvania	10	----	10	40	9	40	8	40	9	45
Delaware	9	50	11	10	9	25	8	30	9	44
Maryland	9	55	11	45	10	----	8	50	10	7
Virginia	9	45	10	55	9	50	8	35	9	46
West Virginia	9	45	10	25	9	55	8	50	9	44
North Carolina	9	45	10	55	9	50	8	40	9	47
South Carolina	9	35	11	5	9	35	8	25	9	40
Georgia	9	45	11	10	9	45	8	35	9	49
Florida	9	45	10	35	9	50	9	20	9	52
Ohio	9	45	10	35	9	40	8	20	9	30
Indiana	9	40	10	50	9	40	8	5	9	34
Illinois	10	10	11	5	9	50	8	15	9	50
Michigan	9	55	10	20	9	35	8	25	9	34
Wisconsin	10	40	11	15	10	10	9	----	10	16
Minnesota	10	30	11	20	10	25	8	45	10	15
Iowa	10	----	10	45	9	50	8	15	9	42
Missouri	10	----	11	15	9	55	8	25	9	54
North Dakota	10	50	11	5	11	----	8	5	10	15
South Dakota	10	15	10	55	10	15	8	30	9	59
Nebraska	10	5	10	50	9	55	8	15	9	46
Kansas	9	45	10	55	10	----	8	25	9	46
Kentucky	9	40	11	15	9	50	8	15	9	45
Tennessee	9	40	11	5	9	45	8	15	9	41
Alabama	9	50	11	15	9	50	8	40	9	54
Mississippi	9	45	11	----	9	45	8	40	9	47
Louisiana	9	30	10	40	9	50	8	50	9	44
Texas	9	50	11	----	10	----	8	45	9	54
Oklahoma	10	----	11	25	10	15	8	30	9	47
Arkansas	9	50	11	----	10	----	8	35	9	51
Montana	10	15	10	25	9	55	8	20	9	44
Wyoming	10	----	10	20	9	35	8	10	9	31
Colorado	9	55	10	20	9	50	8	30	9	39
New Mexico	9	45	10	30	10	----	8	40	9	44
Arizona	9	30	10	15	9	40	8	20	9	26
Utah	9	----	9	30	9	----	7	55	8	51
Nevada	9	30	10	----	9	30	8	25	9	21
Idaho	9	55	10	25	9	45	8	10	9	44
Washington	9	50	10	25	9	55	8	20	9	37
Oregon	9	55	10	35	10	----	8	25	9	44
California	9	45	10	25	9	45	8	55	9	42
United States	9	54	10	54	9	52	8	33	9	48

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Average prevailing farm wage rates, by geographic divisions [1]

Basis of rate, year, and month	North Atlantic States	North Central States	South Atlantic States	South Central States	Western States	United States
Per month, with board:						
1910	$21.47	$24.11	$13.76	$15.56	$32.41	$19.58
1915	23.85	26.23	14.70	16.13	33.51	21.08
1920	52.37	56.44	34.88	36.60	73.36	47.24
1921	38.36	35.53	21.64	22.75	47.75	30.25
1922	37.57	33.73	21.36	22.35	46.22	29.31
1923	43.52	38.63	24.39	24.55	51.02	33.09
1924	44.57	38.41	25.42	25.16	49.18	33.34
1925	45.02	39.27	25.83	25.44	50.63	33.94
Oct. 1, 1922	37.41	34.49	20.53	21.48	45.61	29.03
Jan. 1, 1923	36.85	31.61	20.23	21.48	43.55	27.87
Apr. 1, 1923	41.77	37.04	22.07	22.52	46.43	30.90
July 1, 1923	49.06	40.97	24.14	24.49	56.11	34.64
Oct. 1, 1923	47.55	40.14	24.68	25.26	54.66	34.56
Nov. 1, 1923	46.62	39.84	24.91	25.21	56.07	34.54
Jan. 1, 1924	42.51	35.51	24.09	23.78	48.77	31.55
Mar. 1, 1924	43.91	37.47	24.41	24.37	48.81	32.52
Apr. 1, 1924	45.35	39.68	25.04	24.52	49.66	33.57
July 1, 1924	46.04	39.71	26.28	25.85	50.00	34.34
Oct. 1, 1924	45.50	40.04	25.46	26.24	50.40	34.38
Jan. 1, 1925	41.38	34.20	24.89	24.01	46.64	31.07
Apr. 1, 1925	45.03	40.18	25.39	24.79	49.85	33.86
July 1, 1925	46.35	40.72	26.38	25.75	52.92	34.94
Oct. 1, 1925	45.29	40.80	26.20	26.32	52.02	34.91
Jan. 1, 1926	43.31	35.39	25.35	24.91	47.72	32.03
Per month, without board:						
1910	32.95	33.82	19.77	22.27	46.03	28.04
1915	35.66	36.25	21.06	23.06	48.37	29.97
1920	76.18	75.50	47.37	52.07	99.81	65.05
1921	57.92	49.77	31.31	33.21	68.82	43.58
1922	56.51	47.31	30.71	32.16	66.98	42.09
1923	63.54	53.23	34.75	35.06	72.24	46.74
1924	65.58	52.48	36.06	36.19	71.25	47.22
1925	66.50	53.45	36.67	36.27	72.83	47.87
Oct. 1, 1922	55.41	48.29	30.00	30.99	67.21	41.79
Jan. 1, 1923	54.74	45.27	29.62	31.06	64.19	50.50
Apr. 1, 1923	61.32	51.34	32.32	32.97	67.46	44.41
July 1, 1923	70.63	56.37	34.12	34.91	78.08	48.61
Oct. 1, 1923	67.00	55.06	34.72	36.38	76.45	48.42
Nov. 1, 1923	67.18	54.53	35.18	36.32	77.42	48.45
Jan. 1, 1924	63.66	50.10	34.52	34.75	70.83	45.53
Mar. 1, 1924	65.52	51.50	35.17	34.73	69.82	46.16
Apr. 1, 1924	66.91	53.69	35.21	35.43	71.99	47.38
July 1, 1924	66.64	53.39	36.56	37.04	71.83	48.02
Oct. 1, 1924	66.36	54.60	37.08	37.05	71.91	48.46
Jan. 1, 1925	62.42	48.26	35.37	35.25	69.29	45.04
Apr. 1, 1925	66.30	53.48	36.03	35.55	71.42	47.40
July 1, 1925	67.34	54.30	37.41	36.56	73.74	48.55
Oct. 1, 1925	66.88	55.10	36.84	37.25	75.19	48.99
Jan. 1, 1926	65.30	50.92	36.39	35.72	70.97	46.54

[1] Yearly averages are from reports by crop reporters, giving average wages for the year in their localities.

Average prevailing farm wage rates, by geographic divisions[1]—Continued

Basis of rate, year, and month	North Atlantic States	North Central States	South Atlantic States	South Central States	Western States	United States
Per day, with board:						
Oct. 1, 1922	$2.16	$1.96	$1.04	$1.07	$2.32	$1.56
Jan. 1, 1923	2.14	1.75	1.02	1.05	2.10	1.46
Apr. 1, 1923	2.28	1.88	1.10	1.10	2.20	1.55
July 1, 1923	2.80	2.25	1.28	1.27	2.67	1.84
Oct. 1, 1923	2.96	2.56	1.36	1.39	2.81	2.02
Nov. 1, 1923	2.81	2.53	1.37	1.38	2.75	1.99
Jan. 1, 1924	2.60	2.20	1.26	1.26	2.47	1.79
Mar. 1, 1924	2.60	2.19	1.29	1.26	2.36	1.78
Apr. 1, 1924	2.64	2.17	1.30	1.25	2.31	1.77
July 1, 1924	2.69	2.24	1.38	1.41	2.33	1.87
Oct. 1, 1924	2.80	2.44	1.36	1.39	2.40	1.93
Jan. 1, 1925	2.50	2.04	1.41	1.29	2.23	1.74
Apr. 1, 1925	2.63	2.16	1.35	1.26	2.22	1.77
July 1, 1925	2.73	2.27	1.41	1.38	2.49	1.89
Oct. 1, 1925	2.78	2.45	1.42	1.40	2.49	1.95
Jan. 1, 1926	2.56	2.09	1.34	1.30	2.35	1.77
Per day, without board:						
Oct. 1, 1922	2.88	2.58	1.40	1.46	3.03	2.07
Jan. 1, 1923	2.84	2.37	1.36	1.43	2.84	1.97
Apr. 1, 1923	3.06	2.53	1.47	1.49	2.93	2.09
July 1, 1923	3.65	3.00	1.70	1.68	3.52	2.44
Oct. 1, 1923	3.79	3.27	1.72	1.77	3.58	2.58
Nov. 1, 1923	3.76	3.28	1.75	1.80	3.51	2.58
Jan. 1, 1924	3.47	2.91	1.70	1.67	3.31	2.38
Mar. 1, 1924	3.47	2.90	1.72	1.65	3.20	2.36
Apr. 1, 1924	3.48	2.88	1.71	1.63	3.13	2.34
July 1, 1924	3.51	2.94	1.77	1.80	3.16	2.43
Oct. 1, 1924	3.57	3.12	1.77	1.85	3.25	2.51
Jan. 1, 1925	3.24	2.75	1.80	1.69	3.02	2.31
Apr. 1, 1925	3.43	2.83	1.76	1.64	3.05	2.33
July 1, 1925	3.54	2.97	1.84	1.71	2.91	2.40
Oct. 1, 1925	3.58	3.14	1.84	1.83	3.33	2.53
Jan. 1, 1926	3.44	2.79	1.76	1.66	3.15	2.33

[1] Yearly averages are from reports by crop reporters, giving average wages for the year in their localities.

Farm Management: Crop Production Requirements

Corn: Labor and material requirements per acre, exclusive of marketing (253 records)[1]

CORN BELT AREAS (CORN HARVESTED FROM STANDING STALKS)

State or region	Average yield per acre	Man labor		
		Prior to harvest	Harvest	Total
	Bushels	*Hours*	*Hours*	*Hours*
Kansas	25	15.6	6.1	21.7
Nebraska	40	9.5	5.0	14.5
S. W. Iowa	48	10.0	6.3	16.3
E. C. Iowa	48	12.0	6.4	18.4
W. Illinois	46	13.1	6.6	19.7
E. Illinois	42	11.0	5.7	16.7
Indiana	49	17.3	8.3	25.6

[1] The labor and material requirements as reported constitute 85 per cent of the operating expense in the Corn Belt and 88 per cent in Eastern districts.

Corn: Labor and material requirements per acre, exclusive of marketing (253 records) [1]—Continued

CORN BELT AREAS (CORN HARVESTED FROM STANDING STALKS)—Continued

State or region	Horse labor: Prior to harvest	Horse labor: Harvested from standing stocks	Horse labor: Total	Seed	Manure	Fertilizer	Twine
	Hours	*Hours*	*Hours*	*Pounds*	*Loads*	*Pounds*	*Pounds*
Kansas	34.5	12.3	46.8	7.7	0.6		
Nebraska	28.3	10.1	38.4	8.0	.7		
S. W. Iowa	30.2	12.7	42.9	8.3	.7		
E. C. Iowa	32.0	12.8	44.8	8.0	1.4		
W. Illinois	33.2	12.9	46.1	8.1	1.0		
E. Illinois	33.5	11.5	45.0	7.7	.6		
Indiana	42.8	16.5	59.3	7.9	1.0	22	

EASTERN AREAS (CORN CUT AND HARVESTED FROM SHOCK)

State	Average yield per acre	Man labor: Prior to harvest	Man labor: Harvest	Man labor: Total
	Bushels	*Hours*	*Hours*	*Hours*
Ohio	45	20.4	28.5	48.9
Virginia	52	22.1	27.9	50.0
Maryland	60	23.5	36.0	59.5
Pennsylvania	62	19.1	31.2	50.3
Delaware	47	19.4	35.1	54.5

State	Horse labor: Prior to harvest	Horse labor: Harvested from shock	Horse labor: Total	Seed	Manure	Fertilizer	Twine
	Hours	*Hours*	*Hours*	*Pounds*	*Loads*	*Pounds*	*Pounds*
Ohio	38.5	14.5	53.0	8.2	2.2	27	2.0
Virginia	41.9	17.7	59.6	10.4	2.0	35	1.6
Maryland	45.2	18.5	63.7	8.7	3.8		2.2
Pennsylvania	40.6	13.4	54.0	7.6	4.0	54	2.8
Delaware	40.0	12.0	52.0	11.9	5.1	76	2.9

[1] The labor and material requirements as reported constitute 85 per cent of the operating expense in the Corn Belt and 88 per cent in Eastern districts.

Cotton: Labor and material requirements per acre (842 records, 1918 crops)

State and county	Records	Yield of lint per acre	Man labor: Prior to harvest	Man labor: Harvest	Man labor: Total
South Carolina:	*Number*	*Pounds*	*Hours*	*Hours*	*Hours*
Anderson	89	248	75	56	131
Barnwell	91	268	73	63	136
Georgia:					
Laurens	85	277	61	64	125
Greene	78	260	74	57	131
Sumter	80	244	81	55	136
Alabama:					
Tallapoosa	89	172	85	39	124
Marshall	90	227	76	51	127
Dale	90	194	67	50	117
Texas:					
Ellis	75	176	31	25	56
Rusk	75	185	47	37	86

State and county	Mule labor: Prior to harvest	Mule labor: Harvest	Mule labor: Total	Seed	Fertilizer	Operating expense[1] covered by foregoing
South Carolina:	*Hours*	*Hours*	*Hours*	*Pounds*	*Pounds*	*Per cent*
Anderson	45	12	57	35	404	86
Barnwell	45	17	62	31	555	86
Georgia:						
Laurens	44	16	60	25	288	85
Greene	47	13	60	35	257	85
Sumter	53	11	64	38	286	84
Alabama:						
Tallapoosa	50	9	59	35	187	87
Marshall	51	8	59	30	333	85
Dale	46	7	53	28	250	85
Texas:						
Ellis	33	4	37	22	--------	79
Rusk	42	8	50	25	145	83

[1] Excluding interest on land.

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Potatoes: Labor and material requirements per acre (461 records, 1919 crops)

State and county	Records	Yield per acre	Man labor		
			Prior to harvest	Harvest	Total
Minnesota:	*No.*	*Bush.*	*Hrs.*	*Hrs.*	*Hrs.*
Clay	51	103	18.3	[2] 10.9	[2] 29.2
Anoka	54	104	34.9	28.8	63.7
Wisconsin:					
Barron	47	152	47.6	45.1	92.7
Waupaca	50	123	41.7	35.7	77.4
Michigan:					
Montcalm	49	109	40.1	33.8	73.9
Grand Traverse	52	124	49.9	40.3	90.2
New York:					
Steuben	50	141	40.8	46.3	87.1
Monroe	50	110	47.9	37.7	85.6
Maine:					
Aroostook	58	254	50.4	[2] 27.2	[2] 77.6

State and county	Horse labor			Seed	Manure	Fertilizer	Operating expense [1] covered by foregoing
	Prior to harvest	Harvest	Total				
Minnesota	*Hrs.*	*Hrs.*	*Hrs.*	*Bush.*	*Tons*	*Lbs.*	*Per cent*
Clay	46.1	19.6	65.7	12.3	2.3	-------	74.5
Anoka	60.3	26.6	86.9	9.5	6.0	-------	77.2
Wisconsin:							
Barron	61.5	38.8	100.3	11.6	7.1	(3)	80.6
Waupaca	46.3	30.9	77.2	10.6	5.5	-------	82.3
Michigan:							
Montcalm	54.8	30.7	85.5	7.7	6.0	(3)	80.7
Grand Traverse	54.4	23.6	78.0	11.3	5.0	-------	80.4
New York:							
Steuben	58.4	40.0	98.4	11.2	4.5	(3)	81.2
Monroe	76.5	39.5	116.0	13.2	7.1	(3)	81.2
Maine:							
Aroostook	71.1	38.9	110.0	14.0	2.0	1,965	83.5

[1] Excluding interest on land.
[2] Picking not included in time for harvesting and total hours.
[3] Commercial fertilizers not generally used.

Wheat: Labor and material requirements per acre (481 records, 1919)

Region	Records	Yield per acre	Man labor		
			Prior to harvest	Harvest	Total
Spring wheat region:	*No.*	*Bush.*	*Hrs.*	*Hrs.*	*Hrs.*
Grand Forks, N. Dak	39	9.8	3.6	2.2	5.8
Morton, N. Dak	39	4.4	5.4	3.8	9.2
Spink, S. Dak	39	9.9	3.1	3.0	6.1
Clay, Minn	38	8.1	4.2	4.0	8.2
Traverse, Minn	42	8.4	4.1	4.7	8.8
Winter wheat region:					
Ford, Kans	32	13.3	2.8	4.8	7.6
Pawnee, Kans	32	13.9	2.6	4.7	7.3
McPherson, Kans	35	12.7	4.5	4.8	9.3
Saline, Mo	29	16.3	5.1	8.1	13.2
Jasper, Mo	30	19.2	8.1	9.4	17.5
St. Charles, Mo	38	19.6	8.2	8.9	17.1
Phelps, Nebr	30	10.8	3.7	5.5	9.2
Saline, Neb	35	18.1	6.7	8.1	14.8
Keith, Nebr	23	18.1	2.7	6.9	9.6

Region	Horse labor			Seed	Twine	Operating expense[1] covered by foregoing
	Prior to harvest	Harvest	Total			
Spring wheat region:	*Hrs.*	*Hrs.*	*Hrs.*	*Bush.*	*Lbs.*	*Per cent*
Grand Forks, N. Dak	14.6	4.6	19.2	1.4	1.9	59
Morton, N. Dak	19.2	1.4	25.7	1.2	.1	68
Spink, S. Dak	14.8	5.3	20.1	1.2	1.5	62
Clay, Minn	15.1	7.3	22.4	1.4	2.2	67
Traverse, Minn	17.3	8.4	25.7	1.4	2.0	72
Winter wheat region:						
Ford, Kans	12.0	8.8	20.8	.8	1.2	63
Pawnee, Kans	11.7	8.0	19.7	1.0	.5	56
McPherson, Kans	18.8	8.1	26.9	1.1	2.7	63
Saline, Mo	18.5	11.1	29.6	1.3	2.8	63
Jasper, Mo	26.8	12.7	39.5	1.2	2.3	75
St. Charles, Mo	25.1	11.5	36.6	1.1	2.3	68
Phelps, Nebr	13.0	8.6	21.6	1.0	2.7	69
Saline, Nebr	24.7	12.4	37.1	1.4	3.7	71
Keith, Nebr	9.3	10.1	19.4	.9	1.8	59

[1] Excluding interest on land.

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Hay production: Labor and material requirements

MIXED TAME HAY

State	Records	Yield per acre	Man labor: Mowing, raking, hauling	Horse labor: Mowing, raking, hauling	Seed		Operating expense covered by foregoing [1]
					Timothy	Clover	
	Number	*Tons*	*Hours*	*Hours*	*Pounds*	*Pounds*	*Per cent*
Minnesota	11	1.5	7.8	10.1	4.6	4.0	74
Wisconsin	65	1.4	9.1	10.2	4.6	3.8	70
New York	23	1.4	7.9	7.7	9.2	4.9	82
Pennsylvania	37	1.5	7.5	7.8	9.1	10.5	80
Ohio	52	1.6	7.9	8.5	-------	-------	71
New England	9	1.6	10.7	9.5	10.0	[2] 12.0	77

CLOVER HAY

State	Records	Yield per acre	Man labor	Horse labor	Timothy	Clover	Operating expense
Minnesota	31	1.5	8.6	12.4	-------	10.7	79
Wisconsin	37	2.2	14.2	15.5	-------	7.2	79
New York	7	2.0	8.9	9.9	-------	10.1	80
Ohio	20	1.6	11.6	10.5	-------	-------	76
Illinois	4	1.3	8.7	10.0	-------	7.2	-------

TIMOTHY HAY

State	Records	Yield per acre	Man labor	Horse labor	Timothy	Clover	Operating expense
Minnesota	13	1.3	8.0	11.7	5.4	-------	80
Wisconsin	21	1.4	9.1	11.0	5.5	-------	82
Ohio	8	1.2	7.9	9.2	-------	-------	75
Iowa	7	1.8	7.5	8.8	4.0	-------	70

ALFALFA HAY

State	Records	Yield per acre	Man labor: Mowing, raking, hauling	Horse labor: Mowing, raking, hauling	Seed	Operating expense covered by foregoing [1]	Part of acreage cut more than once	
							Two times	Three times
	Number	*Tons*	*Hours*	*Hours*	*Lbs.*	*Per cent*	*Per cent*	*Per cent*
Minnesota	37	2.5	20.2	24.1	11.7	73	80	60
Wisconsin	39	2.4	21.8	21.2	18.0	72	93	59
Iowa	7	2.0	14.0	22.4	15.0	69	100	72
Illinois	8	1.9	19.2	23.7	13.7	63	------	------
Ohio	7	1.8	17.4	13.8	------	67	86	58
New York	12	2.2	14.4	16.0	15.3	69	91	64

[1] Excluding interest on land. [2] Timothy and redtop.

Tobacco: Labor and material requirements per acre

State	Records	Yield	Man labor: Prior to harvest	Man labor: Harvest	Man labor: Total	Horse labor: Prior to harvest	Horse labor: Harvest	Horse labor: Total	Manure	Operating expense[1] covered by foregoing
	No.	*Lbs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Tons*	*P. ct.*
Wisconsin	19	1,300	90.8	104.3	195.1	65.5	25.2	90.7	8	77.8
Kentucky (Burley)[2]	81	1,141	170.6	204.4	375.0	68.5	29.5	98.0	-----	75
Kentucky (dark)	70	825	140.3	115.7	262.0	60.7	28.3	89.0	-----	75

[1] Excluding interest on land.
[2] See Ky. Bul. 229, "Cost of Producing Tobacco in Kentucky."

Oats: Labor and material requirements per acre (301 records)

State	Records	Yield per acre	Man labor: Prior to harvest	Man labor: Harvest	Man labor: Total	Horse labor: Prior to harvest	Horse labor: Harvest	Horse labor: Total
	No.	*Bush.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*
Minnesota	79	35.4	4.2	5.9	10.1	15.7	7.8	23.5
Wisconsin	92	35.7	6.0	9.0	15.0	16.3	7.7	24.0
Ohio	30	34.3	9.0	11.5	20.5	19.4	8.4	27.8
New York	9	50.4	8.3	10.5	18.8	18.0	7.6	25.6
Illinois	38	35.3	2.7	6.1	8.8	9.2	8.4	17.6
North Dakota	53	33.0	2.9	2.7	5.6	13.0	4.4	17.4

State	Seed per acre	Fertilizer	Fuel (coal)	Twine per acre	Operating expense[1] covered by foregoing
	Bushels	*Pounds*	*Pounds*	*Pounds*	*Per cent*
Minnesota	2.6	----------	----------	2.3	71
Wisconsin	2.2	----------	48.9	2.5	71
Ohio	2.3	----------	49.5	2.2	71
New York	2.4	192.1	69.5	2.6	70
Illinois	2.4	----------	43.8	2.1	61
North Dakota	2.0	----------	----------	1.9	59

[1] Excluding interest on land.

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How to use labor and material requirement data in estimating crop costs.—The figures presented in the foregoing tables represent the average crop requirements for the regions investigated, and may be of value to those interested in determining general costs and to individual farmers as a basis for determining approximate costs on their own farms. In either case the method of procedure is the same, the only difference being that average rates should be used for finding regional costs, and the individual farmer should use, if available, the actual hours of labor and rates for labor and materials applicable to his own farm.

It will be understood that the requirements and proportions presented for each crop may be used in approximating costs in those areas only in which the farm practice in general is similar to that of the regions for which the data are given.

The method of estimating the cost of a given crop may be outlined as follows:

(1) Determine the total cost of labor and material per acre by applying current rates to the quantities of labor and materials obtained from the individual's own records, or, if these are not available, use the averages given in the table.

(2) Determine the total operating expense per acre by dividing the cost of labor and material by the percentage figure (per cent of total operating expense) for the given crop in the given region.

(3) Determine the total acre cost of production by adding the interest charge or the cash rent paid for the use of the land.

(4) To determine the cost per bushel or ton divide the total acre cost by the yield per acre.

The following example illustrates the way in which these rules are applied.

Example: Cost of producing wheat, McPherson County, Kans., 1920

Item	Amount per acre	Estimated rates	Cost per acre
Man labor (prior to harvest)..hours..	4.5	$0.30	$1.35
Man labor (harvest)..........do....	4.8	.60	2.88
Horse labor..................do....	26.9	.20	5.38
Seed....................bushels..	1.1	2.50	2.75
Manure [1]..................tons..	.5	2.00	1.00
Twine..................pounds..	2.7	.25	.68

63 per cent of operating expense	$14.04
Total operating expense	22.29
Interest on land (6 per cent on $134)	8.04
Total cost per acre	33.33
Total cost per bushel (15.4 bushels)	1.97

[1] Comparatively few farmers applied manure to the wheatland in McPherson County. When the manure was prorated to all the farms in this group, the application amounted to one-half a ton per acre, and the charge made a total of $1 per acre. The cost of manure on this basis was approximately 5 per cent of the operating expense.

Average quantities of feed and labor required to maintain the hog breeding herd for one production year, Iowa and Illinois, 1921–1922

Item	One litter per year		Two litters per year	
	Per animal per year 1921	Per animal per year 1922	Per animal per year 1921	Per animal per year 1922
Animals:				
Sows and boars....number..	606	345	316	561
Average weight per animal................pounds..	250	238	251	242
Average gain per animal.do....	97	79	79	98
Months on farm......number..	8.04	7.47	10.26	9.37
Feed consumed:				
Corn..................pounds..	1,177.2	1,067.5	1,387.7	1,275.5
Other grain...............do....	103.2	150.4	107.2	68.6
Tankage....................do....	29.4	29.4	35.6	19.8
Skim milk..................do....	90.2	47.2	155.0	110.9
Soy beans..................do....	2.0	1.7	----------	5.6
Oil meal....................do....	8.0	4.8	2.5	.5
Hog meal..................do....	----------	28.5	----------	3.8
Mill feeds..................do....	4.4	.8	7.2	3.2
Labor:				
Man-hours....................	8.28	7.81	11.68	9.28
Horse-hours....................	.77	.34	.82	1.25

Average quantities of feed, labor, and other factors required to produce 100 pounds of pork (from date of breeding until marketed), Iowa and Illinois, 1921–1922

Item	One litter per year			Two litters per year		
	1921	1922	Total	1921	1922	Total
Pounds of pork produced.............	614,959	340,332	955,291	456,668	698,251	1,154,919
Feeds:			*Average*			*Average*
Corn.....pounds..	399.5	404.0	401.1	407.0	404.6	405.6
Oats........do....	17.2	28.4	21.2	21.0	18.2	19.3
Other grain.do....	.7	2.5	1.4	.1	.3	.2
Soy beans...do....	.3	5.1	2.0	.4	5.1	3.2
Tankage.....do....	10.4	7.0	9.2	13.3	8.5	10.4
Skim milk..do....	19.1	9.9	15.8	32.3	21.4	25.7
Other proteins........pounds..	4.1	6.0	4.8	.2	1.1	.8
Mill feeds...do....	.7	.2	.5	1.6	1.0	1.2

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Average quantities of feed, labor ,and other factors required to produce 100 pounds of pork (from date of breeding until marketed), Iowa and Illinois, 1921–1922—Continued

Item	One litter per year			Two litters per year		
	1921	1922	Total	1921	1922	Total
			Average			*Average*
Pasture:						
Unit days	3.70	3.09	3.48	3.27	2.99	3.10
Labor:						
Man-hours	1.53	1.53	1.53	1.73	1.68	1.70
Horse-hours	.29	.30	.29	.34	.46	.41
Veterinary..dollars	.26	.16	.22	.24	.15	.19
Death risk....do	.14	.06	.11	.06	.05	.06
Miscellaneous.do	.17	.19	.18	.17	.19	.18
Investment:						
Equipment.do	2.69	2.43	2.60	2.49	1.67	1.99
Lots........do	1.17	1.60	1.32	1.24	1.15	1.19
Breeding herd ....dollars	2.39	2.48	2.42	1.73	1.74	1.73

Cost of Production Division.

Average quantities of feed, labor, and other factors required to produce 100 pounds gain in pigs after weaning, Iowa and Illinois, 1921–1922

Item	Spring pigs			Fall pigs		
	1921	1922	Total	1921	1922	Total
Number of droves	42	35	77	14	20	34
Number of pounds gained	700,678	549,493	1,250,171	107,519	158,811	266,330
			Average			*Average*
Feeds:						
Corn.....pounds	372.9	379.4	375.8	413.4	399.0	404.8
Oats........do	10.1	15.7	12.6	25.4	19.6	21.9
Other grains.do	.5	1.0	.7	.2	1.3	.8
Soy beans...do	.2	7.8	3.5	.8	1.5	1.2
Tankage.....do	11.2	6.2	9.0	15.5	13.0	14.0
Skim milk..do	15.6	9.5	12.9	39.1	9.7	21.6
Other proteins ....pounds	2.9	2.1	2.6	....	1.0	.6
Mill feeds...do	.2	.1	.2	2.8	.4	1.4
Pasture:						
Unit days	3.28	3.07	3.19	1.80	1.09	1.38
Labor:						
Man hours	.92	.93	.93	1.29	1.52	1.43
Horse hours	.29	.36	.32	.48	.57	.53
Veterinary.dollars	.32	.22	.27	.22	.17	.19
Other costs..do	.11	.15	.13	.14	.18	.16

Average quantities of feed, pasture, and labor per 100 pounds gain, consumed in growing spring and fall pigs to various weights, Iowa and Illinois, 1921–1922

Item	Spring pigs			
	100 to 150 pounds	151 to 200 pounds	201 to 250 pounds	251 to 300 pounds
Number of droves	3	29	37	8
Feed consumed:				
Corn ... pounds	294.3	357.7	379.9	405.2
Oats ... do	21.2	12.0	11.3	15.7
Other grains ... do		1.4	.1	1.2
Tankage ... do	3.0	9.2	7.2	11.2
Other proteins ... do		1.5	4.5	1.9
Soy beans ... do		3.0	5.3	.8
Skim milk ... do	9.4	17.8	12.0	2.7
Mill feeds ... do		.5	.1	
Pasture:				
Days per 100 pounds gain	4.1	3.9	3.1	2.5
Days per pig	4.1	5.9	5.8	5.8
Labor:				
Man-hours	1.22	1.06	.87	.80
Horse-hours	.37	.33	.29	.28

Item	Fall pigs			
	50 to 100 pounds	101 to 150 pounds	151 to 200 pounds	201 to 250 pounds
Number of droves	4	5	16	8
Feed consumed:				
Corn ... pounds	396.5	403.2	413.6	395.9
Oats ... do	22.9	20.3	17.0	34.0
Other grains ... do	1.6	4.4	.4	
Tankage ... do	13.8	12.6	17.3	7.8
Other proteins ... do	4.7	2.4		.3
Soy beans ... do		5.3	.4	1.3
Skim milk ... do	64.4	6.1	10.6	45.6
Mill feeds ... do	4.7	.3	.3	3.6
Pasture:				
Days per 100 pounds gain	2.6	.5	1.2	1.8
Days per pig	1.4	.4	1.7	3.4
Labor:				
Man-hours	3.18	1.64	1.34	1.16
Horse-hours	.49	.43	.54	.55

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Quantities of feed and labor used in the Corn Belt in making 100 pounds gain in corn-fed cattle

State and year	Cattle	Man labor	Horse labor	Initial weight	Total gain	Grain	Protein concentrates	Molasses and prepared feeds	Legume hay	Other hay	Stover and straw	Silage	Pasture
Nebraska:	*Number*	*Hours*	*Hours*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Days*
1918–19	2, 178	4. 9	3. 9	717	295	755	12	5	408	98	5	142	13
1919–20	3, 717	3. 0	2. 1	800	269	766	4	1	454	43	9	93	17
1920–21	2, 829	2. 9	2. 1	871	310	905	3	--------	393	72	17	37	10
1921–22	4, 335	2. 3	1. 1	826	331	825	--------	--------	340	44	9	--------	10
1922–23	4, 233	2. 2	1. 1	876	316	818	1	4	338	32	9	6	8
Average, 1918–1923	17, 292	2. 8	1. 8	826	306	817	3	2	378	52	10	42	11
Iowa:													
1918–19	3, 745	3. 1	2. 7	739	271	752	35	48	151	28	124	433	11
1919–20	4, 199	2. 5	2. 1	785	323	812	4	16	205	74	39	334	15
1920–21	5, 565	2. 3	1. 5	842	350	860	5	9	216	21	42	77	17
1921–22	4, 898	2. 2	1. 1	791	340	871	1	3	212	39	36	77	12
1922–23	4, 933	2. 1	1. 5	786	346	886	1	13	210	44	56	51	13
Average, 1918–1923	23, 340	2. 4	1. 7	793	329	845	7	15	203	40	54	163	14

Illinois:													
1918-19	2, 727	6. 9	4. 0	786	294	524	77	3	110	169	87	1, 736	10
1919-20	4, 573	5. 6	3. 1	819	245	537	58	15	183	126	151	2, 097	9
1920-21	3, 651	4. 7	2. 8	849	252	565	50	4	81	122	161	1, 685	11
1921-22	4, 357	4. 6	2. 4	779	243	646	14	2	103	108	118	1, 460	9
1922-23	4, 815	3. 5	2. 3	831	268	648	22	8	140	132	118	1, 184	15
Average, 1918-1923	20, 123	4. 9	2. 8	813	259	590	41	7	126	130	128	1, 612	11
Indiana:													
1918-19	1, 601	4. 3	1. 1	673	338	400	79	59	43	84	85	1, 392	9
1919-20	2, 968	4. 8	1. 5	793	282	532	43	10	59	45	225	1, 428	12
1920-21	3, 368	4. 6	1. 8	801	277	861	44	1	62	30	258	1, 193	12
1921-22	4, 992	4. 0	3. 1	842	245	857	15	1	24	28	365	1, 064	14
1922-23	3, 934	3. 5	2. 1	793	264	767	12	16	61	21	346	815	13
Average, 1918-1923	16, 863	4. 2	2. 1	798	271	683	33	15	49	37	280	1, 139	12
Missouri:													
1918-19	3, 560	3. 7	5. 1	732	264	278	105	66	65	42	196	804	43
1919-20	4, 974	3. 6	3. 7	809	252	548	46	16	157	26	174	764	38
1920-21	5, 174	3. 1	3. 2	843	341	677	42	5	152	17	115	509	38
1921-22	5, 003	2. 8	3. 6	766	339	730	5	18	89	35	105	162	41
1922-23	5, 808	2. 4	3. 1	803	324	614	5	30	142	87	247	185	46
Average, 1918-1923	24, 519	3. 0	3. 6	795	307	602	33	24	125	43	166	420	41

Basic requirements of feed and labor for making 100 pounds gain on corn-fed cattle of different weights (average, 1918–1923)

State and class of cattle	Cattle	Man labor	Horse labor	Initial weight	Total gain	Average daily gain	Grain	Protein concentrates	Molasses and prepared feeds	Legume hay	Other hay	Stover and straw	Silage	Pasture
Nebraska:														
1,000 pounds and over	*Number* 3,467	*Hours* 2.8	*Hours* 1.5	*Pounds* 1,066	*Pounds* 272	*Pounds* 2.21	*Pounds* 931	*Pounds* 2	*Pounds* 5	*Pounds* 402	*Pounds* 28	*Pounds* 7	*Pounds* --------	*Days* 5
750 to 1,000 pounds	8,045	2.8	1.8	880	293	1.90	877	3	1	384	55	11	51	10
500 to 750 pounds	3,941	3.0	2.1	645	354	1.63	705	4	2	374	61	11	75	19
Under 500 pounds	1,460	2.5	1.4	427	351	1.72	645	1	--------	299	62	1	--------	8
Iowa:														
Heavy	3,659	2.3	1.7	1,071	291	2.16	1,009	6	15	246	33	50	102	7
Medium	10.894	2.4	1.8	868	330	1.83	870	8	17	183	33	60	157	14
Yearlings	5,845	2.4	1.7	647	338	1.71	772	4	6	168	49	58	256	19
Calves	2,486	2.2	1.2	410	370	1.71	726	11	29	310	61	24	83	12
Illinois:														
Heavy	1,924	5.0	2.9	1,072	244	1.68	823	40	9	188	107	141	1,324	9
Medium	11,493	5.3	3.1	864	255	1.54	634	48	5	131	140	142	1,711	10
Yearlings	5,000	4.3	2.4	658	286	1.45	443	33	11	114	116	91	1,538	15
Calves	860	4.2	1.2	434	287	1.36	448	29	3	57	68	65	1,360	11

Indiana:														
Heavy	2,718	3.8	3.3	1,100	207	1.82	1,086	11	6	22	29	405	870	12
Medium	7,809	4.6	2.2	872	274	1.66	711	37	12	51	26	327	1,305	12
Yearlings	3,183	4.2	1.3	639	299	1.56	519	36	15	71	59	171	1,143	16
Calves	2,501	3.3	1.6	424	323	1.47	513	37	29	41	47	170	861	11
Missouri:														
Heavy	1,926	3.4	4.4	1,029	265	1.60	786	27	48	104	29	113	321	39
Medium	14,401	3.0	3.7	874	317	1.35	618	35	21	123	47	200	430	44
Yearlings	5,982	3.0	3.4	657	305	1.42	562	29	22	138	31	133	454	39
Calves	2,014	2.9	2.2	417	296	1.38	424	33	30	104	62	58	399	32

2.3

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Yearly feed, bedding, and man and horse labor requirements per cow in dairy herd

State and region	Year	Labor	Animal power	Concentrates			Roughage			Bedding
				Purchased	Home-grown	Total	Dry	Silage	Total	
		Hours	*Hours*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Massachusetts	1916–17	185.0	17.00			2,662	4,075	7,817	11,892	
Do	1916	150.0	9.00			2,430	4,379	5,984	10,363	
Pennsylvania	1909–13	170.0	21.00			1,423	2,308	8,311	10,619	
Maryland	1919	201.3	29.60	1,747	512	2,259	4,848	6,320	11,168	
Wisconsin	1909–12	214.0	33.00			1,605	1,907	7,081	8,988	
Do	1920			1,100	990	2,090	2,440	7,590	[1] 10,625	
Minnesota:										
Northfield	1905–09	132.7	35.10	326	538	864		5,590	5,590	
Marshall	1906–09	92.4	22.40	209	789	998		4,028	4,028	
Halstad	1904–09	137.2	17.40	46	722	768		5,531	5,531	
Northfield	1908–12	145.0	40.00			1,058	3,917	4,020	7,937	
Halstad	1912–16	160.0	17.00			866	4,843	2,993	7,836	
Cokato	1913–16	132.0	34.00			1,119	3,972		3,972	
Nebraska	1917–20	113.6	4.20	163	1,366	1,529	4,275	3,593	7,868	340
Washington	1917–20	121.0	1.00	925	262	1,187	3,336	6,474	9,810	295
Louisiana	1918–20	164.5	23.70	1,866	27	1,893	538	1,171	1,709	4
North Carolina	1915–17	336.3	86.70	2,555	59	2,614	2,844	6,620	9,464	
Do	1908–14	262.0	55.00			2,320	4,298	3,867	8,165	
Indiana	1915–17	164.5	16.20	1,198	848	2,046	3,301	7,276	10,577	720
New Jersey:										
Sussex County	1921	182.6	20.10			2,577	3,832	2,075	5,907	
South Jersey	1921	202.0	16.30			2,597	3,394	6,392	9,786	
Michigan	1909–12	230.0	32.00			2,855	3,663	11,638	14,301	

[1] Includes 595 pounds succulent feed other than silage.

Feed units per dairy cow obtained in a year from concentrates, roughage, and pasture in seven widely scattered districts [1]

State and time of study	Year	Number of cows	Feed units per cow: Concentrates	Feed units per cow: Roughage	Feed units per cow: Pasture [2]	Feed units per cow: Total for year	Average production of milk per cow per year	Feed units per pound of milk	Percentage of total feed furnished by pasture	Percentage of total feed cost represented by pasture [3]
							Pounds			
North Carolina (1915–1917)	1st	301	1,711	2,046	1,170	4,927	4,908	1.004	23.7	7.1
	2d	256	2,486	2,216	856	5,558	4,922	1.129	15.4	5.2
Indiana (1915–1917)	1st	334	1,898	2,295	1,481	5,674	6,877	.825	26.1	17.5
	2d	404	1,902	2,454	1,400	5,756	6,987	.824	24.3	11.5
Vermont (1916–1919)	1st	444	999	2,255	2,184	5,438	5,415	1.004	40.1	10.6
	2d	403	1,023	2,381	2,134	5,538	5,111	1.083	38.5	9.6
Washington (1917–1920)	1st	533	937	2,216	2,062	5,215	7,369	.707	39.5	24.2
	2d	514	1,297	2,393	2,284	5,974	8,323	.717	38.2	20.7
Nebraska (1917–1920)	1st	268	1,510	2,418	1,336	5,264	5,806	.906	25.3	19.8
	2d	266	1,221	2,617	2,170	6,008	5,843	1.028	36.1	22.3
Louisiana (1918–1920)	1st	452	2,079	281	282	2,642	2,994	.882	10.6	10.6
	2d	441	2,452	332	546	3,330	3,263	1.020	16.4	5.9
Delaware (1919–1921)	1st	249	1,984	1,404	2,077	5,465	5,556	.983	38.0	11.9
	2d	282	1,467	1,465	2,220	5,152	5,326	.967	43.0	20.0
Total		5,417								
Average									29.6	14.1

[1] From Yearbook, U. S. Department of Agriculture, 1923.

[2] The feed units obtained from pasture were figured by using the feed unit consumption of the same cows during the winter. According to this method, pasture furnished an average of 8.78 feed units per cow per day.

[3] The cost of pasture was based on interest on the land value, taxes, upkeep of fences, and similar items.

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2.3

Unit requirements for producing 100 pounds of milk in different sections of the United States

Item	Indiana [1]		Vermont [2]		North Carolina [3]	
Average yearly milk production per cow..........pounds..	6,937		5,252		4,915	
Per cent butterfat..........	3.8		3.9		....	
	Winter	Summer	Winter	Summer	Winter	Summer
Grain..........pounds..	38.6	20.0	33.1	8.7	57.8	48.4
Dry roughage.......do....	66.8	27.4	129.9	18.7	78.5	36.9
Succulent roughage..........do....	147.6	60.1	191.3	27.8	181.5	67.0
Hauling and grinding concentrates...dollars..	0.03	0.014	0.02	0.005	......	......
Bedding.........pounds [4]..	20.3	......	11.2	......	$0.008	......
Pasture.............acres [4]..	......	0.04	......	0.10	$0.012	$0.205
Human labor.....hours..	2.5	2.2	2.7	2.0	3.6	3.2
Horse labor.........do....	0.3	0.2	0.6	0.4	[5] 1.8	[5] 1.8
Other costs.......dollars..	0.385	0.393	0.555	0.425	0.537	0.495
Credit for calves..........part of calf [4]..	0.012	0.013	0.025	0.009	$0.548	$0.430
Credit for manure..........pounds [4]..	332	54	382	56		

Item	Washington [6]		Louisiana [7]		Nebraska [8]	
Average yearly milk production per cow..........pounds..	7,833		3,106		5,823	
Per cent butterfat..........	3.7		4.4		3.65	
	Winter	Summer	Winter	Summer	Winter	Summer
Grain..........pounds..	29.4	5.2	72.4	52.5	41.2	11.0
Dry roughage.......do....	92.9	7.5	38.3	1.9	95.3	51.2
Succulent roughage..........do....	143.3	40.4	78.4	8.1	93.6	29.3
Hauling and grinding concentrates...dollars..	0.022	0.003	0.095	0.050	0.016	0.004
Bedding.........pounds..	9.0	0.1	0.3	......	11.1	0.5
Pasture.............acres [9]..	......	0.025	$0.155	$0.197	$0.108	$0.653
Human labor.....hours..	1.9	1.3	5.8	5.0	2.0	1.9
Horse labor.........do....	0.01	0.015	0.9	0.7	0.06	0.08
Other costs.......dollars..	0.576	0.406	1.220	0.803	0.869	0.889
Credit for calves..........part of calf..	0.017	0.009	0.033	0.023	0.02	0.01
Credit for manure..........pounds..	115	13	128	78	244	20

[1] U. S. Department of Agriculture Bulletin 858.
[2] U. S. Department of Agriculture Bulletin 923.
[3] N. C. Department of Agriculture Bulletin 266, March Supplement, 1920.
[4] Given in dollars for North Carolina.
[5] Farmers retailed their own milk.
[6] U. S. Department of Agriculture Bulletin 919.
[7] U. S. Department of Agriculture Bulletin 955.
[8] U. S. Department of Agriculture Bulletin 972.
[9] Given in dollars for Louisiana and Nebraska.

Kinds and average quantities of feed per horse, by districts

Type of farming—State and district	Grain			
	Corn	Oats	Barley	Miscellaneous
	Bush.	*Bush.*	*Bush.*	*Lbs.*
Corn Belt	40.2	25.5	--------	--------
Ohio:				
Madison County	36.1	4.6	--------	--------
Seneca County	37.4	29.2	--------	--------
Indiana:				
Madison County	37.0	13.5	--------	--------
Montgomery County	36.2	23.4	--------	--------
Illinois:				
West Central [1]	57.2	39.8	--------	28
Livingston County	39.9	29.2	--------	--------
Knox County	38.3	24.4	--------	--------
Iowa:				
Iowa County	48.3	69.2	--------	--------
Winter wheat belt:				
Great Plains	14.1	23.4	6.0	23
Southern area [2]	7.5	34.7	1.0	73
Western area [3]	5.3	12.6	14.2	--------
Northern area [4]	31.1	21.4	2.1	--------
McPherson County, Kans	14.6	40.6	.4	10
Pacific Northwest wheat region:				
Washington-Idaho [5]	.1	46.7	3.8	30
Sherman County, Oreg	--------	3.9	4.5	207
Spring wheat belt:				
North Dakota [6]	4.7	73.3	6.8	234
Cotton Belt:				
Eastern [9]	62.4	5.8	--------	--------
Western, Ellis County, Tex	54.8	64.8	--------	--------
Tobacco farms:				
Virginia [10]	48.8	1.1	--------	11
Kentucky—				
Burley	44.1	2.0	2.1	--------
Dark	44.6	3.4	--------	--------
Dairy farms:				
Wisconsin [11]	16.4	79.2	--------	602
Minnesota:				
Steele County	34.0	37.0	2.3	40
Cottonwood County	27.2	58.4	--------	--------
Southern area [12]	14.7	78.0	3.3	196
Other types:				
Middlesex County, N. J	70.5	.7	--------	110
Western New York [13]	8.8	41.8	.4	660
Kingsbury County, S. Dak	26.9	72.1	--------	--------
Gallatin County, Mont	--------	38.3	.7	--------
Twin Falls County, Idaho	.4	2.6	3.3	--------

[1] Cass, Menard, and Sangamon Counties.
[2] Harper County, Kans., and Alfalfa County, Okla.
[3] Thomas, Sheridan, Trego, Gove, and Logan Counties, Kans.
[4] Phelps and Kearney Counties, Nebr.
[5] Whitman County, Wash., and Latah County, Idaho.
[6] Practically all counties in the State represented.
[9] Anderson and Barnwell Counties, S. C., Greene, Laurens, and Mitchell Counties, Ga.; and Marshall and Lauderdale Counties, Ala.
[10] Charlotte and adjacent counties.
[11] Dane, Waukesha, Waupaca, Barron, Manitowoc, Eau Claire, Iowa, and Marquette Counties.
[12] Freeborn, Renville, Pope, Rice, Wright, Grant, Norman, Sibley and Kandiyohi Counties.
[13] Orleans, Wyoming, Genesee, Monroe, and Seneca Counties.

Kinds and average quantities of feed per horse, by districts—Continued

Type of farming—State and district	Roughage				
	Hay	Straw	Corn stover	Miscellaneous	Pasture days
	Tons	*Tons*	*Tons*	*Tons*	*Number*
Corn Belt	1.30	0.96	0.79	--------	173
Ohio:					
Madison County	1.63	.13	3.90	--------	172
Seneca County	2.72	.12	1.59	--------	112
Indiana:					
Madison County	1.66	1.04	.33	--------	169
Montgomery County	1.54	.98	.17	--------	168
Illinois:					
West Central [1]	.77	1.11	.22	0.02	148
Livingston County	.47	2.49	.03	--------	196
Knox County	1.15	1.23	.06	--------	196
Iowa:					
Iowa County	2.96	.57	--------	--------	104
Winter wheat belt:					
Great Plains	1.32	.05	.13	--------	269
Southern area [2]	1.27	--------	.09	--------	283
Western area [3]	1.25	--------	.06	--------	305
Northern area [4]	1.38	--------	.20	--------	225
McPherson County, Kans	1.65	.65	.35	.04	213
Pacific Northwest wheat region:					
Washington-Idaho [5]	2.45	.01	--------	--------	(6)
Sherman County, Oreg.	1.44	.23	--------	[7] 1.91	(6)
Spring wheat belt:					
North Dakota [8]	3.12	.96	.21	.03	83
Cotton Belt:					
Eastern [9]	.80	--------	.48	--------	(6)
Western, Ellis County, Tex	1.30	.09	.16	--------	80
Tobacco farms:					
Virginia [10]	1.86	--------	1.18	--------	38
Kentucky—					
Burley	1.30	.11	1.54	--------	150
Dark	1.52	.08	.78	--------	84
Dairy farms:					
Wisconsin [11]	1.95	.73	.17	.21	63
Minnesota:					
Steele County	1.73	--------	.56	.05	48
Cottonwood County	2.59	--------	.01	.01	64
Southern area [12]	3.29	--------	.13	--------	86

[1] Cass, Menard, and Sangamon Counties.
[2] Harper County, Kans., and Alfalfa County, Okla.
[3] Thomas, Sheridan, Trego, Gove, and Logan Counties, Kans.
[4] Phelps and Kearney Counties, Nebr.
[5] Whitman County, Wash., and Latah County, Idaho.
[6] Not available.
[7] Chaff.
[8] Practically all counties in the State represented.
[9] Anderson and Barnwell Counties, S. C.; Greene, Laurens, and Mitchell Counties, Ga.; and Marshall and Lauderdale Counties, Ala.
[10] Charlotte and adjacent counties.
[11] Dane, Waukesha, Waupaca, Barron, Manitowoc, Eau Claire, Iowa, and Marquette Counties.
[12] Freeborn, Renville, Pope, Rice, Wright, Grant, Norman, Sibley, and Kandiyohi Counties.

Kinds and average quantities of feed per horse, by districts—Continued

Type of farming—State and district	Roughage				
	Hay	Straw	Corn stover	Miscellaneous	Pasture days
Other types:	*Tons*	*Tons*	*Tons*	*Tons*	*Number*
Middlesex County, N. J.	2.34	.67	.99		33
Western New York [13]	3.44	1.35	.03	.06	48
Kingsbury County, S. Dak.	2.27	.43	.41		85
Gallatin County, Mont.	2.64			.03	254
Twin Falls County, Idaho	5.44	.03			64

[13] Orleans, Wyoming, Genesee, Monroe, and Seneca Counties.

Production Standards

Average number of horses, farm and crop area per farm, and crop acres per horse

Type of farming—State and district	Average number of horses per farm	Acres per farm		Crop acres per horse	
		Total	In crops	All farms	Non-tractor farms
Corn Belt:					
Ohio—					
Madison County	8.2	363	276	34.1	
Seneca County	4.8	202	140	28.0	
Indiana—					
Madison County	4.8	218	176	32.6	
Montgomery County	6.0	270	205	34.2	
Illinois—					
Livingston County	8.4	247	211	25.1	
Knox County	7.0	256	198	28.3	
Winter wheat belt:					
Great Plains	8.6	481	338	39.1	30.7
Southern area [1]	7.9	324	260	32.9	25.5
Western area [2]	10.6	828	500	47.2	36.6
Northern area [3]	7.7	377	297	38.6	31.0
McPherson County, Kans.	7.7	253	213	27.8	25.4

[1] Harper County, Kans., and Alfalfa County, Okla.
[2] Thomas, Sheridan, Trego, Gove, and Logan Counties, Kans.
[3] Phelps and Kearney Counties, Nebr.

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Average number of horses, farm and crop area per farm, and crop acres per horse—Continued

Type of farming—State and district	Average number of horses per farm	Acres per farm		Crop acreage per horse	
		Total	In crops	All farms	Non-tractor farms
Pacific Northwest wheat region:					
Washington-Idaho [4]	8.5	274	243	28.5	27.7
Sherman County, Oreg.	15.8	1,025	802	50.6	38.8
Spring wheat belt:					
North Dakota [5]	9.6	596	401	41.8	37.6
Cotton Belt:					
Eastern [6]	3.0	144	71	23.1	23.1
Western, Ellis County, Tex.	6.1	168	150	26.3	26.3
Tobacco farms:					
Virginia [7]	2.8	149	42	15.0	15.0
Kentucky—					
Burley	5.5	226	124	22.6	17.0
Dark	6.9	173	101	14.7	14.7
Dairy farms:					
Minnesota—					
Steele County	6.5	180	125	19.1	16.8
Cottonwood County	6.0	177	133	22.3	22.1
Other types:					
Middlesex County, N. J.	6.1	127	85	13.8	12.8
Kingsbury County, S. Dak.	8.8	266	208	23.8	23.8
Gallatin County, Mont.	10.3	322	231	22.4	22.4
Twin Falls County, Idaho	4.7	75	64	13.6	13.6

[4] Whitman County, Wash., and Latah County, Idaho.
[5] Practically all counties in the State represented.
[6] Anderson and Barnwell Counties, S. C.; Greene, Laurens, and Mitchell Counties, Ga.; and Marshall and Lauderdale Counties, Ala.
[7] Charlotte and adjacent counties.

Normal day's work in hauling to market with wagon and one man and two horses (loading, hauling, and unloading): Number of loads per day, by distance hauled, for each commodity

Distance hauled, miles	Baled cotton	Corn from crib	Barreled crops	Bagged crops	Baled hay	Small grain from bin	Cabbage	Loose cotton	Potatoes from cellar	Loose hay
1	6.57	5.00	4.57	5.29	5.25	4.51	3.87	2.50	3.17	3.64
2	3.86	3.75	3.89	3.91	3.92	3.37	3.27	2 53	3 02	2 69
3	3 63	2 95	3 20	3 23	3 05	2.93	2.58	2.50	2.29	2.19
4	2.62	2.47	2.80	2.64	2.51	2.52	2.34	2.09	2.06	1.99
5	2.29	2.15	2.11	2.11	2.19	2.14	1.89	1.81	1.78	1.72
6	2.55	1.99	2.06	2.04	2.03	1.99	1.80	2.00	1.66	1.82
7	2.33	1.79	1.57	1.87	1.87	1.71	1.70	2.50	1.46	1.48
8	1.66	1.31	1.12	1.27	1.44	1.40	1.15	1.14	1.22	1.22
9	1.00	1.18	1.33	1.25	1.50	1.42	1.25	1.00	1.10	1.30
10	1.33	1.17	1.09	1.19	1.60	1.16	1.00	1.21	1.10	1.09

Labor requirements for hauling and spreading limestone:[1] *Number of men and horse hours required for both hauling and spreading of 1 to 5 tons of limestone at a distance of 1 to 4 miles*

Number of tons	1 mile		2 miles		3 miles		4 miles	
	Man	Horse	Man	Horse	Man	Horse	Man	Horse
1	1.2	3.1	1.8	4.2	2.3	5.3	2.9	6.4
2	2.5	6.2	3.6	8.4	4.7	10.6	5.8	12.8
3	3.7	9.3	5.4	12.6	7.1	15.9	8.7	19.2
4	5.0	12.4	7.2	16.8	9.4	21.2	11.6	25.6
5	6.2	15.5	9.0	21.0	11.7	26.5	14.5	32.0

[1] Illinois Agricultural Handbook.

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Normal day's work in building wire fence: Length of fence that two men can build in a day, both when setting posts and when driving them, and when they are spaced at various distances

Kind of fence	Day's work, posts spaced			
	12 feet or less	13 to 16½ feet	17 to 21 feet	25 to 37 feet
Barbed wire:				
2 strands—	*Rods*	*Rods*	*Rods*	*Rods*
Posts driven	--------	89.5	95.0	166.9
Posts set	58.7	71.5	75.0	121.5
3 strands—				
Posts driven	64.0	89.1	116.4	156.0
Posts set	43.7	58.7	68.3	95.4
4 strands—				
Posts driven	76.6	83.2	92.4	95.0
Posts set	39.3	47.9	50.6	70.8
5 strands—				
Posts driven	52.2	56.7	70.9	100.0
Posts set	25.3	34.1	38.7	46.2
6 strands—				
Posts driven	29.5	56.7	67.5	--------
Posts set	19.4	26.4	32.0	34.1
Narrow-woven wire with 2 or more barbed wires:				
Posts driven	48.7	53.0	74.1	89.8
Posts set	26.3	33.0	37.9	47.1
Wide-woven wire with 1 barbed wire:				
Posts driven	50.9	55.3	77.2	94.2
Posts set	27.2	33.9	39.9	49.7
Wide-woven wire without barbed wire:				
Posts driven	61.3	65.4	80.2	108.5
Posts set	30.6	39.0	45.8	56.7

Farm Costs

Incomes From Farming: Pre-War, War, and Post-War Incomes.—Average incomes from farming as shown by farm-business surveys grouped into three periods, namely: The pre-war period, 1910–1915, a time of rather normal price levels; the war period, 1916–1919, a time of high price levels; and the post-war period, 1920–1923, a time when prices of farm products were declining more rapidly than those of nonagricultural commodities.

Item	1910–1915—23,083 records, 183 localities, 33 States	1916–1919—7,531 records, 67 localities, 24 States	1920–1923—5,649 records, 32 localities, 17 States [1]
Land area per farm........acres..	183	162	285
Capital	$16, 854	$18, 142	$23, 313
Receipts	$2, 440	$3, 230	$3, 514
Expenses	$1, 174	$1, 504	$2, 326
Farm income	$1, 266	$1, 726	$1, 188
Labor income	$407	$708	$−307
Percentage on capital	4. 9	6. 3	2. 9
Family living from the farm	(2)	$582	$519
Farmer's labor	$440	$509	$673
Other family labor	$98	$143	$174

[1] This group includes a number of large farms in the grain-growing regions, thus making the land area per farm greater than in the other two groups.

[2] No data available.

Definition of Terms—*Capital.*—The value at the beginning of the farm year of all real estate, machinery, livestock, and other property used to carry on the farm business. It includes the value of the dwelling but not of the household furnishings.

Receipts.—Proceeds from the sale of crops produced during the farm year, the increase from livestock, the increase in the inventory value of crops and supplies during the year, and the receipts from outside labor, rent of buildings, etc. The family living from the farm is not included as a farm receipt.

Expenses.—Annual expenditures made in carrying on the farm business, including the value of unpaid labor performed by members of the family, the decrease, if any, in the inventory value of crops and supplies during the year, and depreciation in value of buildings and equipment. The value of the farmer's own labor and the household or personal expenses are not included.

Farm income.—The difference between the farm receipts and the farm expenses as defined above.

Labor income.—The wages of the farm operator computed as the difference between the farm income as defined and interest on the farm capital, usually at the rate of 5 per cent. A minus labor income means that the farm income was not sufficient to cover, at the assumed rate, the interest on the capital by the amount shown. The value of the family living from the farm is considered as a perquisite of the operator and not included in the labor income figure.

Percentage on capital.—The earnings of the farm capital computed as the difference between the farm income and the farmer's estimate of the value of his own labor at going wage rates divided by the total capital at the beginning of the year.

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Average labor incomes when the farms of each locality are arranged in five groups according to the size of the labor income

Labor income groups	1910–1915—23,083 records, 183 localities, 33 States	1916–1919—7,531 records, 67 localities, 24 States	1920–1923—5,649 records, 32 localities, 17 States
Highest one-fifth	$1,570	$2,268	$1,624
Second highest one-fifth	644	$1,060	209
Third highest one-fifth	314	605	−319
Fourth highest one-fifth	28	190	−869
Lowest one-fifth	−520	−585	−2,178
Average	407	708	−307

Incomes from Farming, 1922–23.—The following table summarizes figures of farm returns furnished by owner operators in every county where farming is carried on. The distribution of replies is roughly proportional to the number of farmers in the States concerned, especially in the more important agricultural States. The farms reporting are larger in size and greater in value than the average for the United States, according to the 1920 census. From this, together with the fact that replies submitted are voluntary and all from farmers operating their own farms, it may be assumed that these farms are more efficiently managed than the average, and that the return per farm is undoubtedly greater than the average for all farms in the United States.

Averages indicate a slightly better season in 1923 than in 1922. Small differences in the size of most of the items, however, may be attributed to possible deviations of the figures given from their true mean values quite as justly as to real changes in the amounts spent for each. "Interest paid" and the amount "spent for farm improvements" are shown separately; they are outlays of the farmer, but not of the farm business for the current year, interest paid being the lender's share in the proceeds of the business, and improvements being made for several years' service. The further reduction in land valuations reflects the continuation of the period of unsatisfactory returns to many farmers.

The relative size of the noncash item, representing the value of the family living from the farm (house rental not estimated), and the cash income or net-results figures, directs attention to the importance of this factor in the economy of the farm family.

Incomes from farming, 1922–1925

Item	1922	1923	1924	1925
Number of reports	6,094	16,183	15,103	15,330
Size of farms ... acres	252	300	303	304
Value of real estate	$13,586	$14,530	$14,323	$14,184
Value of farm personality (Jan. 1)	2,844	2,960	2,937	2,965
Receipts:				
Crop sales	816	850	1,012	933
Sales of livestock	660	760	780	897
Sales of livestock products	454	550	570	585
Miscellaneous other sales	42	80	72	76
Total	1,972	2,240	2,434	2,551
Cash outlay:				
Hired labor	331	350	384	386
Livestock bought	204	240	222	242
Feed bought	175	210	248	244
Fertilizer	57	60	66	69
Seed	43	40	44	47
Taxes (farm property)	174	190	192	191
Machinery and tools	123	110	103	119
Miscellaneous	150	150	151	179
Total	1,257	1,350	1,410	1,477
Receipts less expenses	715	890	1,024	1,074
Increase in inventory	202	130	181	223
Net result	917	1,020	1,205	1,297
Interest paid	(1)	230	230	225
Spent for farm improvements	(1)	140	133	127

NONCASH, ESTIMATED ITEMS, REPORTED BY THREE-FOURTHS OR MORE OF THE NUMBER OF FARMS (AVERAGES FOR FARMS REPORTING)

Value of goods produced and used on the farm	$294	$250	$266	$283
Value of family labor, including owner	716	870	789	793
Change in value of real estate during year (− shows decrease)	−52	−66	+145	+168

[1] Not reported for 1922.

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What the farm furnishes toward the family living

Year and locality	Items and quantity or value per farm per year											
	Corn and wheat	Potatoes [1]	Fruit and vegetables	Butter	Milk	Beef and pork [2]	Poultry	Eggs	Total value of food [3]	Wood	Use of house	Total of all items
1918												
	Bushel	*Bushel*	*Dollars*	*Pounds*	*Gallons*	*Pounds*	*Number*	*Dozen*	*Dollars*	*Cords*	*Dollars*	*Dollars*
New Hampshire: Hillsborough County	1	25	61	37	976	186	19	73	299	12	156	533
Virginia: Frederick County	15	12	60	82	143	842	29	59	370	7	168	556
North Carolina: Catawba County	38	27	52	90	289	572	33	64	458	11	89	573
Georgia: Sumter County (white)[4]	32	30	44	91	264	900	53	80	469	16	179	690
Sumter County (colored)[4]	36	29	29	65	204	743	26	44	374	13	59	471
Florida: Hillsborough County		17	39	70	276	469	28	82	301	5	113	432
Ohio: Washington County [4]	21	20	59	145	237	460	22	77	410	12	83	511
Indiana: Clinton County [4]	7	10	43	106	166	729	45	110	386	3	91	493
Iowa: Tama County [4]		23	2	158	249	727	3	157	412	5	228	654
Warren County [4]	1	11	37	135	262	550	48	145	366	7	144	529
Average for 1,754 farms	10	23	44	96	300	661	37	88	402	10	137	569

1919												
New York: Niagara County [5]	4	28	66	143	145	285	14	88	358	14	160	558
Virginia: Frederick County	12	10	68	85	160	765	31	66	384	7	170	571
Florida: Hillsborough County	1	19	49	74	223	534	26	75	352	4	128	499
Polk County		1	26	16	53	58	13	33	83	1	143	230
Mississippi: Jones County [5]	14	49	87	156	341	528	21	62	515	7	85	627
Ohio: Washington County [4]	24	20	63	145	244	450	21	58	415	12	90	525
Indiana: Clinton County [4]	7	3	41	94	155	753	49	95	348	3	127	490
Idaho: Twin Falls County [4]		8	78	108	266	253	40	109	342		174	516
Idaho and Washington: Palouse region [4]		14	63	131	276	644	37	130	409	1	197	608
Average for 1,213 farms	5	18	63	111	220	474	29	87	365	5	151	531
1920												
Rhode Island: [5]	3	17	59	16	303	106	26	80	313	1	186	501
Virginia: Frederick County	10	10	44	75	162	827	25	65	312	6	191	513
Florida: Hillsborough County		17	52	60	254	487	23	67	359	4	141	520
Ohio: Washington County [4]	14	11	48	114	209	460	13	73	282	5	89	379
Wisconsin: Walworth County [4]	4	21	23		273	284	18	94	172		276	448
Idaho: Twin Falls County [4]		10	81	122	248	339	36	130	372		208	580
Idaho and Washington: Palouse region [4]		15	49	115	297	726	31	134	382	1	190	573
Oregon: Sherman County [4]			37	113	291	507	20	204	408		236	644
Average for 1,174 farms	4	13	47	77	244	479	25	115	319	1	208	531

[1] In some localities potatoes were included with "fruit and vegetables."
[2] Dressed. Pork averages 90.3 per cent of the total for all farms.
[3] Includes some miscellaneous items not listed in previous columns.
[4] In cooperation with the State college or agricultural experiment station.
[5] By courtesy of State college or agricultural experiment station.

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What the farm furnishes toward the family living—Continued

Year and locality	Corn and wheat	Pota-toes	Fruit and vege-tables	Butter	Milk	Beef and pork	Poul-try	Eggs	Total value of food	Wood	Use of house	Total of all items
	Items and quantity or value per farm per year											
1921	*Bushel*	*Bushel*	*Dollars*	*Pounds*	*Gallons*	*Pounds*	*Number*	*Dozen*	*Dollars*	*Cords*	*Dollars*	*Dollars*
Vermont: Orange and Windsor Counties [4]	-------	34	42	33	277	249	12	76	233	12	135	464
Rhode Island [5]	1	17	85	25	365	148	22	99	367	2	284	666
Florida: Hillsborough County [4]	-------	17	49	62	294	428	25	81	286	4	148	451
Ohio: Washington County [4]	21	18	52	122	222	512	22	74	293	7	95	399
Iowa: Tama County [5]	-------	-------	61	165	336	774	33	162	291	-------	351	642
Warren County [5]	-------	-------	61	142	464	709	39	174	299	-------	246	545
South Dakota: Jones County [5]	-------	-------	-------	184	374	1, 055	35	166	315	10	102	445
Montana: Sheridan and Daniels Counties [4]	-------	19	28	148	206	372	27	107	201	-------	112	313
Colorado: Weld County [5]	-------	25	24	131	353	355	49	197	261	-------	244	505
Idaho: Twin Falls County [4]	-------	13	84	138	310	322	40	151	297	-------	237	534
Idaho and Washington: Palouse region,[4]	-------	8	48	114	338	677	28	152	283	1	195	480
Washington: King and Pierce Counties [4]	-------	27	37	58	219	125	31	110	173	8	126	316
Yakima County [4]	-------	22	39	115	321	362	31	138	226	-------	162	388
Oregon: Sherman County [4]	-------	-------	41	120	308	604	22	214	308	-------	240	548
Average for 2,102 farms	1	14	49	112	325	488	30	143	272	5	208	494

1922												
Delaware: Sussex County [4]	18	18	38	72	115	715	47	83	248	4	148	419
Florida: Hillsborough County [4]	--------	13	40	60	277	322	27	93	247	4	157	420
Polk County [4]	--------	--------	--------	17	[illegible]2	[illegible]6	8	30	39	1	2[illegible]2	263
Ohio: Washington County [4]	1	19	58	120	238	493	23	81	264	9	95	377
Iowa: Cal oun County [5]	--------	22	35	152	301	591	36	155	268	--------	252	520
Humboldt County [5]	--------	33	40	184	345	437	36	143	283	--------	404	687
South Dakota: Jones County [5]	--------	--------	--------	178	262	866	28	148	288	3	91	392
Kansas: Finney County [4]	--------	5	31	107	359	646	69	200	293	--------	204	497
Thomas and Sherman Counties [4]	2	15	44	118	389	684	75	194	339	--------	328	667
Montana: Sheridan and Daniels Counties [4]	4	10	31	145	205	448	23	108	203	--------	114	317
Dawson and Custer Counties [4]	1	19	44	124	230	411	35	184	234	--------	119	353
Colorado: Washington and Lincoln Counties [4]	--------	11	39	124	348	655	69	211	303	--------	237	540
Idaho: Twin Falls County [4]	--------	2	78	96	268	302	38	128	265	--------	242	507
Washington: Yakima County [4]	--------	--------	39	116	355	303	33	172	244	--------	181	425
Oregon: Sherman County [4]	--------	--------	36	115	316	535	46	180	275	--------	238	513
Average for 1,495 farms	2	11	37	115	279	494	40	140	254	1	212	470
Average for 7,738 farms	4	16	48	103	282	525	33	117	320	5	184	518

[4] In cooperation with the State college or agricultural experiment station.
[5] By courtesy of State college or agricultural experiment station.

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MARKETING

Cost of Marketing Livestock

Principal terminal marketing costs, 1921[1]

HOGS

Market	Number of head upon which figures are based	Cents per 1,000 pounds, home weight, straight shipments: Average commission	Average yardage	Average feed	Average commission, yardage, and feed combined
Chicago	124,338	98.7	44.8	34.1	177.6
St. Paul	10,334	82.6	42.1	50.2	174.9
St. Joseph	21,663	88.6	48.7	42.1	179.4
Kansas City	16,589	83.6	50.5	37.8	171.9
Omaha	14,638	86.8	44.0	28.9	159.7
Sioux Falls	14,394	93.8	47.7	38.7	180.2
Buffalo	18,564	77.7	58.6	76.4	212.7
Pittsburgh	37,366	93.8	58.5	71.1	223.4

CATTLE

Market	Number of head	Average commission	Average yardage	Average feed	Combined
Pittsburgh	1,445	104.4	31.0	75.8	211.1
Buffalo	603	86.0	34.0	44.2	170.4
East St. Louis	1,068	99.7	46.3	19.2	165.2
Cleveland	2,224	86.9	31.2	43.1	161.2
Sioux Falls	797	92.5	41.0	26.7	160.1
Kansas City	81	90.6	40.2	20.7	154.4
Chicago	6,063	98.1	36.8	18.5	153.2
Sioux City	1,097	84.3	41.4	16.0	141.6
Milwaukee	596	63.0	23.5	25.3	111.7

SHEEP

Market	Number of head	Average commission	Average yardage	Average feed	Combined
Chicago	15,874	151.1	78.0	(2)	241.3
East St. Louis	1,926	166.0	102.4	(2)	277.8
Kansas City	3,390	214.6	101.2	(2)	321.9
Sioux City	1,856	134.1	81.1	10.7	267.6
Buffalo	1,271	125.1	95.8	44.1	261.2
St. Joseph	2,443	214.0	104.5	(2)	323.7

[1] Data from 237 cooperative shipping associations in the Corn Belt.
[2] Feed cost seldom incurred. If incurred it is included in commissions or yardage.

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Freight and other marketing costs, 1921

Item	Number of head upon which figures are based	Freight		All other costs		Total cost
		Per 1,000 pounds	Percentage of total	Per 1,000 pounds	Percentage of total	
South Dakota sheep to Chicago	1,186	$6.12	66	$3.10	34	$9.22
Iowa cattle to Chicago	3,659	3.80	64	2.12	36	5.92
Iowa hogs to Chicago	128,336	4.02	62	2.50	38	6.52
South Dakota hogs to Sioux City	13,039	3.76	60	2.52	40	6.28
Indiana cattle to Buffalo	288	4.04	60	2.74	40	6.78
Indiana sheep to Buffalo	1,271	5.45	60	3.56	40	9.01
Indiana hogs to Buffalo	17,879	4.43	59	3.07	41	7.50
South Dakota cattle to Sioux City	1,097	3.33	59	2.29	41	5.62
South Dakota sheep to Sioux City	1,723	3.83	56	3.05	44	6.88
Ohio hogs to Pittsburgh	31,907	3.22	54	2.69	46	5.91
Illinois hogs to Chicago	148,108	2.68	54	2.26	46	4.94
Kansas hogs to Kansas City	14,971	2.66	53	2.33	47	4.99
Illinois cattle to Chicago	2,200	2.14	52	2.01	48	4.15
Ohio cattle to Pittsburgh	1,046	2.96	52	2.68	48	5.64
Wisconsin cattle to Chicago	71	2.40	52	2.25	48	4.65
Wisconsin hogs to Milwaukee	14,711	2.25	52	2.10	48	4.35
Indiana hogs to Pittsburgh	5,397	3.73	52	3.39	48	7.12
Ohio cattle to Cleveland	2,424	2.39	51	2.32	49	4.71
Iowa hogs to Omaha	4,553	2.23	50	2.22	50	4.45
Kansas hogs to St. Joseph	7,595	2.63	50	2.62	50	5.25
Ohio hogs to Cleveland	8,372	2.69	49	2.75	51	5.44
Indiana cattle to Pittsburgh	399	3.09	49	3.20	51	6.29
Wisconsin cattle to Milwaukee	596	1.73	48	1.88	52	3.61
Minnesota hogs to St. Paul	7,216	2.52	48	2.71	52	5.23
Minnesota sheep to St. Paul	818	2.98	46	3.49	54	6.47
South Dakota hogs to Sioux Falls	14,808	1.86	41	2.67	59	4.53
South Dakota cattle to Sioux Falls	797	1.67	41	2.36	59	4.03

Percentage of shrinkage in livestock shipments by cooperative associations,[1] 1921

BY DISTANCE

Distance, miles	Cattle: Number of animals	Cattle: Shrinkage percentage of weight shipped	Calves: Number of animals	Calves: Shrinkage percentage of weight shipped	Sheep: Number of animals	Sheep: Shrinkage percentage of weight shipped	Hogs: Number of animals	Hogs: Shrinkage percentage of weight shipped
Up to 100	1, 661	2. 56	16, 869	3. 49	2, 479	8. 90	86, 060	1. 48
100 to 150	3, 518	2. 26	9, 781	4. 99	6, 472	7. 10	112, 419	1. 10
150 to 200	3, 158	3. 46	8, 114	4. 85	5, 139	7. 02	103, 605	1. 25
200 to 250	1, 623	3. 16	1, 767	6. 48	1, 978	7. 22	109, 438	1. 24
250 to 300	350	2. 91	102	4. 83	860	8. 65	4, 612	2. 10
300 to 350	1, 888	4. 09	2, 194	5. 96	1, 026	9. 92	36, 639	2. 11
350 to 400	1, 522	5. 03	5, 641	5. 96	2, 237	10. 40	56, 156	1. 80
400 to 450	1, 070	3. 94	2, 063	7. 40	2, 073	8. 77	41, 021	1. 71
450 to 500	376	4. 20	495	6. 20	648	6. 87	11, 987	1. 62
500 to 550	72	5. 04	------	------	------	------	2, 778	2. 13
550 to 600	220	4. 60	42	7. 75	1, 186	8. 22	2, 751	3. 07

BY MONTHS

Month	Cattle: Number of animals	Cattle: Shrinkage percentage of weight shipped	Calves: Number of animals	Calves: Shrinkage percentage of weight shipped	Sheep: Number of animals	Sheep: Shrinkage percentage of weight shipped	Hogs: Number of animals	Hogs: Shrinkage percentage of weight shipped
January	1, 822	4. 20	3, 858	5. 26	1, 922	5. 20	67, 822	1. 14
February	1, 401	3. 34	4, 172	5. 22	567	5. 88	57, 056	1. 03
March	1, 416	3. 66	6, 183	5. 55	1, 736	6. 95	40, 047	1. 31
April	2, 063	3. 54	5, 517	5. 64	1, 013	8. 55	48, 419	1. 39
May	1, 728	2. 78	5, 632	5. 20	1, 060	9. 20	40, 918	1. 49
June	2, 339	2. 62	4, 386	5. 67	1, 723	10. 13	55, 399	1. 77
July	828	2. 66	2, 541	5. 00	1, 873	8. 32	38, 485	1. 40
August	616	2. 72	2, 691	5. 08	3, 285	8. 90	37, 594	1. 90
September	680	3. 47	2, 332	4. 98	3, 098	8. 11	38, 132	1. 86
October	829	3. 81	2, 794	5. 30	2, 983	7. 79	45, 077	1. 68
November	1, 000	4. 30	3, 919	4. 62	3, 349	7. 93	47, 464	1. 34
December	736	2. 84	3, 053	4. 87	1, 489	7. 60	51, 101	1. 02

[1] Shrinkage represents the difference between shipping-point weight and terminal weight, including the weight of all crippled and dead. Hence, the shrinkage figure is over and above the direct losses due to crippled and dead.

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Percentage of crippled and dead in livestock shipments by cooperative associations, 1921

Distance shipped, miles	Cattle: Number of animals	Cattle: Average weight of animals	Cattle: Crippled	Cattle: Dead	Calves[1]: Number of animals	Calves[1]: Average weight of animals	Calves[1]: Crippled	Calves[1]: Dead
		Lbs.	*P. ct.*	*P. ct.*		*Lbs.*	*P. ct.*	*P. ct.*
Less than 100	2, 330	799	0. 09	------	20, 629	124	0. 07	0. 16
100 to 150	5, 130	934	. 10	------	15, 646	137	. 25	. 30
150 to 200	3, 437	829	. 09	------	9, 776	145	. 09	. 14
200 to 250	2, 427	953	. 17	------	2, 980	203	. 20	. 13
250 to 300	395	1, 055	------	------	102	196	------	------
300 to 350	2, 004	929	------	------	2, 194	162	. 23	. 23
350 to 400	1, 805	854	. 22	------	6, 313	165	. 35	. 41
400 to 450	1, 119	897	------	------	2, 145	177	. 19	. 33
450 to 500	699	879	. 15	------	514	171	. 78	1. 94
500 to 550	101	723	------	------	------	------	------	------
550 to 600	220	923	. 91	------	42	166	2. 38	2. 38

Distance shipped, miles	Sheep: Number of animals	Sheep: Average weight of animals	Sheep: Crippled	Sheep: Dead	Hogs: Number of animals	Hogs: Average weight of animals	Hogs: Crippled	Hogs: Dead
Less than 100	3, 210	75	0. 03	0. 18	97, 439	242	0. 33	0. 12
100 to 150	7, 702	83	. 04	. 35	124, 791	231	. 40	. 20
150 to 200	6, 255	87	. 16	. 30	120, 523	235	. 41	. 24
200 to 250	4, 551	85	. 10	. 31	118, 845	230	. 44	. 18
250 to 300	860	70	------	. 46	4, 764	219	. 21	. 21
300 to 350	1, 266	84	. 08	. 23	37, 400	254	. 89	. 34
350 to 400	2, 898	88	. 41	. 72	78, 293	250	. 74	. 38
400 to 450	2, 190	81	. 64	. 39	43, 517	247	. 82	. 33
450 to 500	648	82	. 15	------	12, 790	241	. 86	. 18
500 to 550	------	------	------	------	2, 997	238	. 60	. 37
550 to 600	1, 186	80	------	2. 36	2, 751	237	1. 27	. 29

[1] Calves were in mixed shipments.

Marketing Range Cattle

Selecting a Market.—Compare freight rates, railroad service, time required to reach the market, commission and yardage charges, feed costs, and the demand at each available market for the number, kind, and grade of livestock intended for sale. Consult local railroad agent in regard to freight rates, permissible mixtures, minimum loads, bedding of cars, and feeding-in-transit stations. Write to any responsible commission firm regarding market demands, commission charges, and other market expenses at its market. When selling locally, sell by weight if scales are available.

Shipping—(See 6.8.) *Preparation.*—Handle cattle carefully so that they will lose the least amount of weight and will reach market in condition to make the best impression on the buyer. Loads of uniform size, color, and quality sell best. Feed moderately, and do not hold cattle off water before shipping. Animals that have been feeding on silage, oil meal, legume hay, or succulent grass should have these feeds reduced and be given dry hay or stover for two or three days before loading. This adjustment of feed will tend to prevent scouring and excessive shrinkage.

Ordering cars.—The railroad stock car in most common use is 36 feet, 7 inches in length and is referred to as the 36-foot car. Another popular length is 40 feet, 6 inches. In ordering cars, give the railroad agent advance notice, make order in writing and in duplicate, show the number and length of car wanted, intended destination of shipment, date of intended loading, and whether the cars are to be bedded by the shipper or carrier. Freight rates usually are based on certain minimum loading weights for different kinds of livestock, the shipper being required to pay the charge for a minimum load, even though the actual load is less than the prescribed minimum. The minimum weights for cattle, established by the Interstate Commerce Commission for interstate shipment, in most sections are 22,000 pounds for 36-foot cars, and 24,000 pounds for 40-foot cars. Require the carrier to furnish a clean car, or a car bedded in accordance with instructions. A shipper is permitted to furnish his own bedding, and in that event no charge is made by the carrier. Railroads generally charge a fee of $1 for bedding single-deck cars. Sand is excellent for bedding in summer and straw in winter. Manure, cinders, rock dust, coal, or similar materials should not be used.

Loading stock.—Load on special livestock pick-up days. If the days designated for shipping are unsatisfactory, consult the neighboring shippers to ascertain which days are most desirable and then take up the matter with the proper railroad authorities. Deliver the livestock to the loading station in ample time to allow the animals to cool and rest before being loaded. In hot weather make the drive slowly at night or early in the morning. Before loading inspect the car for bad odors, loose floor and wall boards, nails, and blocks of wood. Examine car doors to see that they are in good working order. After loading, fasten the doors securely and put the bull boards in place. Car doors bulging at the bottom may cause broken legs. Avoid delays in loading, since the local pick-up train may have only a short time to make the junction for consolidation into a through-service stock train. Load slowly and carefully so as to avoid overheating. Strong, heavy cattle ride better when loaded rather snugly, but avoid overloading. Load animals that are fairly uniform in size. In loading, prod poles with sharp

metal points should not be tolerated. Separate vicious animals by partitions or tie with strong rope. Always tie bulls in the car. Mixed loads should be avoided where possible. When shipping loads of mixed stock, make inquiry of the railroad agent regarding freight rates and regulations for different mixtures.

Billing cars.—Give proper shipping instructions, and see that the contract signed complies with the instructions given. Note on the contract any deviations from its provisions, such as changes in the cars ordered, valuation assigned to stock, agreement regarding feeding, watering, loading, and unloading in transit, loss in transit, free return transportation, and billing. Instead of a declaration of value insert the words "ordinary livestock" in the contract, except for animals valued chiefly for breeding, show, or racing purposes. Give specific instructions as to the number of times, if at all, stock is to be fed en route. If this is done and an extra feeding is made necessary by reason of delay, the railroad can not impose the service charge for unloading and reloading at the extra feeding station. When two or more cars of the same kind of livestock are shipped and it is desired that they be kept separate at the feeding stations, instructions should be given on the waybill. Insist that the shipments be rushed through to their final destination over the quickest and best route, specifically designating each road to handle shipment. The shipper should be certain that the stock is consigned to the right party and that the number and kind of each species loaded is indicated in the contract. It is advisable to sign a release for all shipments to the 36-hour limit so that the animals will not have to be unloaded at the end of 28 hours. This should not be done, of course, when the condition of stock makes it inadvisable. Wire the commission firm the number and initials of car, time of departure, routing, kind of stock, and send a copy of bill of lading by mail. When billing to one market with stop-over privileges to try another market en route, the usual practice has been to bill to a commission firm at the ultimate destination, but to specify in the contract that the stock is to be unloaded for feed, water, and sale at the intervening market. If the shipper does not accompany the stock it should be billed in care of a commission firm at the first market, and this firm should be instructed by wire or letter in advance as to what should be done with it.

Handling in transit.—When shipping long distances which require stops en route for rest, feed, and water, notify the conductor of the stock train a sufficient time in advance where the stock is to be unloaded, the length of rest period, and the quantity and kind of feed wanted. If this is done, the attendants at the feeding-in-transit station can have the feed properly distributed in the yards, and the railroad company can provide the necessary train crew, power, and equipment. Even though no notice is given, the conductor must stop in time to comply with the 36-hour law. Request for service should not be canceled on short notice, as oftentimes the crews, power, and equipment have been assembled at considerable expense. If the unloading, feeding, watering, and reloading of stock are performed by railroad employees a service charge is usually made. The first one into an unloading station is usually the first out. Immediately upon arrival report to the commission firm any inattention, neglect, or unsatisfactory service on the part of the transportation company in order that proper claims may be filed for loss and damages.

Costs of Marketing.—The costs of marketing livestock through the central markets can be divided into four major groups: (1) Local expenses incurred in assembling and loading stock, (2) transportation or freight costs, (3) losses in transportation, such as crippling, killing, and shrinkage in weight, and (4) terminal costs.

Local expenses.—May include horse and man labor used in assembling and loading stock and in bedding car, feed in local yards and in car, bedding material for cars, rope for tying bulls, and lumber where needed for partitions and repairs to car. Bedding costs usually range from nothing to as high as $2 per car, depending on the material used.

Transportation costs.—Include the carrier's charge for hauling, which is usually based on a certain rate per 100 pounds for a minimum load, a charge for unloading and feeding in transit where necessary to comply with the 36-hour law, and, in some instances, a charge for switching when the car is turned over to a terminal or belt railroad which controls the tracks leading into the central-market yards. The local railroad agent can furnish rates to the different markets.

Losses in transportation.—Data available indicate that approximately 1 out of every 1,000 cattle received at the central markets arrives dead or dies after unloading and before sale. Cattle losses in the winter months average 2 to each 1,000 animals received. Losses from death will increase materially in the shipment of extremely thin cattle in severe weather. Loss from unusual shrinkage is usually the result of severe weather conditions or improper handling.

Terminal costs.—Include commission, yardage, and feed. A service charge is imposed by the commission firm for representing the shipper and for selling the stock. Commission is usually charged on a "per head" basis, with maximum charges per car. Yardage and feed charges are those imposed by the stockyards company for pen space, and feed and water for the animals while they are being held for sale. Yardage is always on a "per head" basis, there being separate rates for the different species. Feed charges are made on the basis of the quantity of feed ordered by the commission firm for the stock. Minor items of expense are inspection fees, blanket fire insurance while the animals are in the stockyards, and fees collected to finance organizations that look after the general interests of the shipper or the livestock industry. These fees usually are 5 to 20 cents per car. The carriers usually allow one-way or round-trip transportation for an attendant.

Shrinkage of Livestock.—Factors which affect shrinkage are: (1) Season of year and weather, (2) condition and age of animals, (3) kind of feed on which the animals had subsisted and especially that to which they had access just before loading, and length of time animals are held off feed and water before loading, (4) kind and length of trip to the shipping point, (5) how the animals were handled while being loaded, (6) length of time in transit and care animals receive en route, (7) time of arrival at public stockyards and time intervening between arrival and weighing at yards, and (8) condition of selling pens at the market.

"Shrinkage," as commonly used in reference to marketing livestock, means the net loss between the weight at the loading station or shipping point and the hoof or sale weight at the market. Although shrinkage increases with time in transit, the greater proportion of the loss in weight occurs in the first few hours en route. Cattle lose

from 2 to 7 per cent of their home weight when shipped to market and given access to feed and water after arrival. An increase or decrease of 1 per cent in shrinkage on a steer weighing 1,100 pounds and selling for 8 cents a pound means a difference of 88 cents in the total returns for the animal, or about $19 on a carload of 24,000 pounds.

Cooperative Shipping and Marketing.—Marketing livestock through cooperative shipping associations is done only in a small way in the range country, although the range round-up was one of the earliest forms of cooperative endeavor. Where individual producers in a community have less than a carload of stock to market at one time, it is well for them to get together and organize a shipping association in order to reduce marketing costs and obtain central-market prices. The nonstock, nonprofit form of organization is the most desirable for livestock-shipping associations. Incorporation is advisable. A sufficient volume of business to attract a capable manager is necessary. The manager selected should have the confidence of the members, be honest and congenial, and have a thorough knowledge of livestock production and marketing and an understanding of business methods and principles. He should give a surety bond, the expense thereof being paid from the association funds. The association must have the loyal support of its members, who must realize that the organization is cooperative, not automatic. They should cooperate with the manager, keep all promises made to him, and play fair with their fellow members. An efficient accounting system should be kept and an annual audit made. The officers and board of directors should keep fully informed regarding financial affairs of the association.

Leading Markets Handling Range Cattle—*Source of supply.*—According to official estimates based on the census enumeration, the 11 western range States on January 1, 1925, had 32.3 per cent of the country's beef cows and heifers 1 year old and over, 8.8 per cent of the cows and heifers kept for milk, 19.9 per cent of the steers 1 year old and over, 14.4 per cent of the bulls, and 18.3 per cent of the calves, or 17.4 per cent of all cattle. The States of Texas and Oklahoma, in which many of the cattle are produced under range conditions, had 22.3 per cent of the beef cows and heifers, 7.1 per cent of the cows and heifers kept for milk, 14.4 per cent of the steers, 10.9 per cent of the bulls, and 14.1 per cent of the calves, or 12.8 per cent of all cattle. Kansas, Nebraska, South Dakota, and North Dakota produce a large number of grass cattle under conditions similar to those prevailing in States farther west. These four States had 17.6 per cent of the beef cows and heifers, 11.2 per cent of the cows and heifers kept for milk, 23.5 per cent of the steers, 14.9 per cent of the bulls, and 19.7 per cent of the calves, or 15.9 per cent of all the cattle. Three of these States—Kansas, Nebraska, and South Dakota—lie partly in the Corn Belt, and many of their cattle are produced under Corn Belt conditions. A large percentage of these cattle, however, originated in the range country, being received from there for finishing. It is difficult, therefore, to estimate accurately the total supply of strictly range cattle or to determine the number of such cattle marketed annually. The importance of this group of 17 States in beef-cattle production is shown by the fact that on January 1, 1925, they had 46.1 per cent of all the cattle, 72.3 per cent of the beef cows and heifers, 27.1 per cent of the cows and heifers kept for milk, 57.8 per cent of the steers, 40.1 per cent of the bulls, and 52.2 per cent of

the calves in the United States. On January 1, 1929, this group of States had 12 per cent fewer cattle than on January 1, 1925.

Location of markets.—Cattle from the range country are received at 25 of the 66 public stockyards in this country. Seventeen of these stockyards are located within or adjacent to the range country and get almost all their receipts from that area. Such receipts include both fed and grass cattle. Some of the 17 stockyards function largely as feeding-in-transit stations, cattle passing through them being forwarded to other markets for final disposition. The other 8 markets are located in the Corn Belt and receive livestock from both Corn Belt and range States. Seven of them rank among the nation's leading livestock markets, but the eighth is of only minor importance. The average annual receipts at these seven markets include 75 per cent of all the cattle and calves passing through the 25 markets that handle range cattle. The bulk of the supply of these seven markets, however, does not come from the range country. In 1925 the 11 Western States contributed directly only 5.4 per cent, Texas 3.1 per cent, and Oklahoma and North Dakota 3.4 per cent each, of the receipts at these markets. Kansas, Nebraska, and South Dakota furnished 32.4 per cent. The total receipts from the 17 States constituted only about 48 per cent of all the cattle received at these seven markets.

Many of the cattle in Nevada, Utah, Arizona, southern Idaho, and western Wyoming, find an outlet in California. Cattle from northern Idaho, western Montana, Washington, and Oregon are shipped largely to Portland, Seattle, and Spokane. Most of the California cattle are consumed within the State. Colorado and Wyoming cattle are marketed at Denver and Missouri River markets. Cattle from eastern and central Montana find an outlet in Omaha, Sioux City, St. Paul, and Chicago. Texas cattle are shipped to San Antonio, Fort Worth, Oklahoma City, Kansas City, and East St. Louis. New Mexico cattle go to Kansas City, Denver, and Fort Worth. Many Texas and New Mexico cattle, particularly steers, yearlings, and calves, are shipped directly to Kansas and Oklahoma pastures and to Corn Belt feed lots for further finishing before being sold for slaughter.

Seasonal movements.—Range cattle being finished on grass usually are marketed in the fall at the end of the grass season, although a number of Texas, New Mexico, and Arizona cattle move to market, and to pastures outside of these States, in the late spring and summer, and most of the California grass cattle are marketed from April to July, inclusive. At the market range cattle are bought either for immediate slaughter or for return to the country for further finishing. Marketings of cattle and calves during September, October, and November bring 35 per cent of the year's total receipts at public stockyards. Inspected slaughter for this period is ordinarily less than 30 per cent, whereas the stocker and feeder movement is about 40 per cent of the respective year's totals.

Rules and regulations governing public stockyards.—The packers and stockyards act became effective August 15, 1921. In accordance with its provisions it is administered by the Secretary of Agriculture through the Packers and Stockyards Administration, a division of the Bureau of Animal Industry of the Department of Agriculture, created for that purpose. Under the act the Secretary of Agriculture is authorized to exercise certain

general supervisory powers over the activities of packers, stockyard owners, market agencies, and dealers, commonly referred to as commission men and traders. Some of the main purposes are to maintain free, open, and competitive conditions in the packing industry and at public livestock markets, to protect livestock producers and owners against discriminatory, unfair, and deceptive practices, and to prevent excessive and unreasonable charges. The Secretary is authorized to ascertain and give public notice as to the stockyards that come within the purview of the act and to require registration by market agencies and dealers and the filing of schedules of rates and charges by market agencies and stockyard companies. All packers doing interstate business are subject to the act. On July 1, 1929, 71 public stockyards, in which 4,561 commission men, traders, and other market agencies were doing business, were subject to the act. Approximately 900 packing concerns are listed as subject to the act. It is the policy of the department to enforce the act and bring about improvements in the marketing machinery of the country through informal procedure when possible, but formal procedure is resorted to when necessary.

Marketing Feeder Cattle Direct to Feeders—*Methods.*—Three special methods for marketing stocker and feeder cattle have been evolved in recent years by the western range cattlemen: (1) Selling directly by mail order to customers obtained through advertising in livestock market papers, farm journals, and catalogues; (2) selling large droves at auctions held at central points in the Corn Belt, and (3) selling directly to Corn Belt feeders who visit the range to make their purchases.

Essentials for direct marketing.—Standardization of product is the foundation of these several marketing programs. It is believed by the producers that standardization, coupled with sound business integrity, in a few years will establish a national market for range cattle in the stocker and feeder area with mutual benefit to the western producer and the Corn Belt farmer.

Advantages and disadvantages of direct marketing.—The chief advantage of direct dealing between the range man and the Corn Belt feeder is that it permits the direct movement of cattle from pastures to feed lots with the least possible delay, hence they are less likely to become stale or to develop shipping fever. In some instances savings to both buyer and seller can be effected through the elimination of central-market expenses, such as commission, yardage, feed charges, and speculator profits. The chief disadvantage is the difficulty of buyers and sellers making satisfactory contacts and of arriving at a price which is mutually satisfactory. When dealing by mail, the buyer must depend entirely on the integrity and judgment of the seller. If he visits the range country to inspect offerings, he is compelled to incur heavy expense for travel. If he depends on an agent, he often finds that the cost of buying is rather high, even though the agent represents a large number of purchasers. A distinct service is involved which must be paid for regardless of the method used. If the range producers assemble their cattle at some central point in the Corn Belt convenient to prospective purchasers and offer them at auction, they must incur a heavy expense for holding pens, auctioneer, and feed, and at the same time assume considerable risk in the way of unfavorable weather and slow bidding.

Market Demands and Prices—*Market demands.*—Cattle that are most profitable to the producer or feeder are

those that will produce the maximum quantity and quality of beef most economically. Purebreds or grades are most likely to meet these requirements and command the highest prices on the market, whether for slaughter or feeder purposes. Because of lack of finish, many range cattle sell as feeders instead of for slaughter. The demand for feeders is greatest during the fall months after feed crops have matured or are definitely assured. The feeder demand is influenced by the demand for fed cattle. When heavy-fed cattle command a premium, reasonably fat, aged grass cattle are usually in good demand to go to feed lots for a short feed. At times well-finished, lightweight cattle on the baby-beef order bring top prices, and there is then a strong demand for well-bred range calves and yearlings to go into feed lots. The demand for this class of cattle has increased materially in recent years as a result of increasing consumer demand for choice beef of light weight.

Market grades.—The grade of an animal is probably the most important factor in determining its price. Choice and Prime cattle invariably bring more money than do Common and Medium. These grades, however, are found only in cattle that have been fed considerable grain or other concentrates. Grass cattle for slaughter seldom grade better than Medium or Good, and many of inferior breeding will grade as Common. A study of the distribution of grades in market receipts of steers in 1920 showed the following proportions:

Grade:	Per cent
Choice and Prime	4.5
Good	22.0
Medium	53.0
Common	17.0
Cutters and Low Cutters	3.5

Inasmuch as on the slaughter market most range cattle grade Medium or Common, it will be seen that they comprise the grades in the most abundant supply, hence meet the greatest competition in that market. Fortunately, however, a large percentage of the range cattle reaching markets are bought for further finishing and classed as stockers or feeders. The grades of feeder cattle in descending order are Fancy, Choice, Good, Medium, and Common. The grade of a feeder steer like that of a slaughter steer will depend largely on its conformation, finish, and quality. To bring the best prices as feeders a carload of range steers not only should have the desired conformation, finish, and quality, but should be uniform in age, color, and weight.

Prices.—Common and Medium grade range steers usually sell highest in the spring and early summer, when relatively few of them are being marketed. During this period there is a market scarcity of cattle suitable for feeders. Range steers grading good generally meet with less competition from corn-fed steers of similar grade during the summer and fall; hence, they usually command best prices at that time. As the receipts of range cattle increase during September, October, and November, the supply of Common and Medium steers becomes more plentiful and prices decline to the year's lowest levels.

The variations in the spread between the average price of Medium steers and the average price of Choice and Prime steers will indicate the relative fluctuations in demand and supply of these grades at market. The variations are shown in the following table:

Average differentials between monthly average prices of Choice and Prime and Medium steers at Kansas City, Mo., 1924–1928

Month	Differential	Month	Differential	Month	Differential
January	$3.56	May	$2.14	September	$4.24
February	3.22	June	2.16	October	4.51
March	2.63	July	2.93	November	4.40
April	2.22	August	3.48	December	4.05

Tariff on livestock, meats, and animal products.—Under the tariff act, effective September 21, 1922, the following items are subject to duty when imported from any foreign country into the United States:

Cattle, weighing less than 1,050 pounds each, 1½ cents per pound; weighing 1,050 pounds each or more, 2 cents per pound; fresh beef and veal, 3 cents per pound; tallow, ½ cent per pound; oleo oil and oleo stearin, 1 cent per pound.

Sheep and goats, $2 per head; fresh mutton and goat meat, 2½ cents per pound; fresh lamb, 4 cents per pound.

Swine, ½ cent per pound; fresh pork, ¾ cent per pound; bacon, hams, and shoulders, and other pork, prepared or preserved, 2 cents per pound; lard, 1 cent per pound; lard compounds and lard substitutes, 4 cents per pound.

Meats, fresh, prepared or preserved, not specially provided for, 20 per cent ad valorem. *Provided:* (Reference to compliance with meat-inspection administration and food and drugs act.)

Horses and mules, valued at not more than $150 per head, $30 per head; valued at more than $150 per head, 20 per cent ad valorem.

Skins of all kinds, raw, and hides not specially provided for (admitted free of duty).

Marketing Country Hides and Skins.—(See 4.5.)

Marketing Range Sheep and Lambs

Selecting a Market.—The same general principles that govern the selection of a market for cattle apply to sheep and lambs. The best consumers' markets are in the large cities on the Pacific coast and the North Atlantic seaboard, because the bulk of the market supply of dressed lamb and mutton is distributed and consumed in these two regions. More than 62 per cent of all the sheep and lambs slaughtered under Federal inspection during the five years, 1924 to 1928, were slaughtered in Chicago, metropolitan New York, Omaha, and Kansas City. The San Francisco Bay district is the most important slaughter center on the Pacific coast. Many range lambs are first marketed as feeders and are either sold on the range directly to finishers, dealers, or speculators, or are shipped to feeder markets located within or adjacent to the range country. A common practice is to contract feeder lambs in advance of delivery.

Importance of Grade.—The better grades and preferred cuts of lamb are in particular demand by that class of consumers in the large cities who do not scrimp in buying food. This class demands and will pay a good price for the best grade of lamb but will not buy at any price when the grade is low. For this reason lamb is some-

times classed as a luxury meat. The lamb market is very sensitive to variations in supply and demand, and prices of low-grade lambs usually decline more than those of the better grades when the market is oversupplied. Slaughterers claim that the supply of best-grade lambs is seldom equal to the demand.

Shipping.—The same general care should be used in loading sheep and lambs as has been outlined for cattle; likewise, the same general rules and regulations apply regarding such matters as ordering and billing cars and feeding in transit. The same general types of stock cars are used, except that some railroads furnish double-deck cars upon request. The minimum loading weights for 36-foot cars are 12,000 pounds for single-deck and 22,000 pounds for double-deck cars. The minimum weight for 40-foot cars is 14,000 pounds and 24,000 pounds for singles and doubles, respectively.

Costs of Marketing.—The costs of marketing sheep and lambs through central markets are similar to those for marketing cattle, but average higher per 100 pounds. This is because of a higher freight rate and the difficulty of loading cars with sheep and lambs as heavily as with cattle. Losses through death and crippling in transit usually exceed cattle losses. Such losses are increased during severe weather. Charges at the central markets are usually on the same basis as for cattle; that is, by the head or carload. Feed costs at central markets are negligible, as sheep and lambs consume only a small quantity of hay before they are sold. Feeding charges at feeding-in-transit stations may be very significant if the animals are held at such stations for any considerable time. Sheep shrink more than cattle, the usual range being from 6 to 12 per cent. Shrinkage is greatest during the spring and summer months and is appreciably greater for shipments over 250 miles than for shorter distances.

Seasonal movements.—Lambs constitute about 90 per cent of market receipts of sheep and lambs, and make up the bulk of the stocker and feeder movement. About 43 per cent of the total year's receipts from the range States go back to the country for further finishing, and 75 per cent of this movement takes place during the five months, July to November, inclusive. Conditions under which sheep production is carried on result in the great bulk of lambs being born within a period of a few months, over 75 per cent being dropped during March, April, and May. October, with 14.4 per cent of the year's total, is the month of heaviest market receipts. September is second, with 12.6 per cent; and August and November are tied, with 10 per cent each. February is the lightest month, with 5.8 per cent, followed by April and March, with 5.9 and 6 per cent, respectively. The percentage marketed during each of the remaining five months varies from 6.6 per cent to 7.6 per cent. During the period, January to May, market receipts consist largely of fed western stock from Corn Belt and western feed lots. Weight is a factor in determining the price, and the time that lambs can be fed with profit is definitely limited. Lambs weighing over 85 pounds often are penalized in the market price. Early spring lambs from California and Arizona begin to move to market in April, and shipments increase steadily through May as the supplies of fed lambs dwindle. During these two months there is a movement of grass-fat sheep, mostly wethers from Texas, but this movement depends on feed conditions in that State during the winter and early spring. The

lambs born in sheds in Idaho, Oregon, and Washington begin coming to market by the middle of June and continue through July. During the next three months, the movement from the range increases until it reaches the October peak. Market receipts during December consist largely of short-fed stock, which were bought in the late summer or early in the fall to clean up stubble fields and farm roughage, and lambs which have been fattened in cornfields.

Leading Markets Handling Range Sheep and Lambs.—*Source of supply.*—Market receipts of sheep and lambs are divided into two general kinds—natives and westerns. Natives include those animals raised on farms usually in the farming States. Westerns, as the name implies, include animals coming from States where sheep are raised on a large scale on open ranges or in big pastures. Natives run strongly to the mutton and open-wooled type of the Down breeds, although there are important native States where merinos predominate. Westerns tend largely to a fine-wool foundation based upon merino blood, although some areas devoted to producing early market lambs use rams of open-wooled breeds. A large proportion of the westerns sold out of growers' hands are bought as feeding animals and are finished for slaughter by the use of grain and other concentrates, this feeding period extending from two to four months. Natives go to market almost exclusively for slaughter. There were 47,171,000 sheep and lambs in the United States on January 1, 1926, according to official estimates based on the census enumeration, and 56.8 per cent of these were in the 11 Western States. Texas had 10.7 per cent, so that at least 67 per cent of the total supply of sheep and lambs can be termed "westerns." The actual percentage is higher, as many of those in Corn Belt feed lots on the date of the estimates were of western origin.

Location of markets.—The same 25 public stockyards which handle western range cattle also receive western sheep and lambs. Most of the 17 markets located within or contiguous to range territory are feeding-in-transit stations for sheep and lambs billed to other markets or being transferred to other feeding grounds, although some are very important stocker and feeder markets. The latter include Denver, Ogden, and Salt Lake City. Omaha ranks first in receipts of western sheep and lambs, and probably first as a primary stocker and feeder market. Chicago, Denver, and Kansas City rank next in receipts, and these four markets probably receive more than half of all western lambs passing through public stockyards.

Distributing receipts to avoid congested markets.—One of the greatest problems in marketing sheep and lambs is that of regulating the market movement so as to avoid alternate shortages and market gluts. Since the only outlet for lamb is the fresh-meat trade, a temporary oversupply of live lambs tends to depress prices more than in the case of other classes of livestock. Probably the greatest number of range operators usually find it necessary to ship in the late summer and fall, but slight adjustments in practices may effect a more stable movement. Congestion, with its inevitable price depression in the fall, is aggravated by the large number of native lambs which are marketed at this time. A large percentage of these native lambs are of inferior quality and have a decidedly unfavorable influence on the market. Not only do they hurt the sale of good lambs, but, because of their inferior condition due to poor breeding, insufficient feed, internal parasites, or lack of castration and docking, they yield a poor quality of meat and generally are produced at a loss. This problem is one of giving the sheep more

and better attention, as well as giving more careful consideration to market requirements.

Market prices—*Factors which determine price.*—The more important factors which determine the market price of sheep and lambs are: (1) Available supplies, (2) consumptive demand, (3) grade of the animal, and (4) price of wool.

Yearly variations in the annual supply of sheep and lambs are equally as extreme as the wide variation in the supply at market centers. Annual per capita consumption of lamb and mutton has varied from 4.6 to 8.1 pounds in the 29-year period, 1900–1928, averaging about 6 pounds. Consumption also varies widely in different sections of the country, ranging from less than 1 pound per capita in rural sections east of the Rocky Mountains to more than 22 pounds among rural inhabitants of Nevada. Consumption is greatest in the Northwestern and far Western States, and least in the South Atlantic and West North Central States.

The price of any given lot of sheep and lambs will depend on the grade of the animals constituting the lot. The quantity and condition of the wool that a sheep or lamb carries is also an important factor in determining the price of the animal. Wool itself fluctuates widely in price, and the quantity carried by the animal will depend on the season of the year and on the time of its last shearing. It is not uncommon for the wool on a lamb to be worth about $2. Prices of sheep and lambs are very sensitive to variation in general business, trade, and economic conditions. This is due largely to the fact that lamb and mutton are still regarded as luxuries by many people.

Seasonal variation in prices.—The highly seasonal character of market movements of sheep and lambs naturally results in seasonal variations in prices. The relationship between the price of live lambs and the dressed product is obscured to some extent by the variation in the quantity of wool carried by the animal. Fat lambs usually sell highest in March, April, and May, and aged sheep reach their peak in April. The high point for lambs is coincident with the final marketings of the previous year's crop and is reached before the advent in any num- reach their peak in April. The high point for lambs is registered just before the time of annual shearing, and since the animals are carrying full fleece this price is usually more apparent than real. The difference between wooled and shorn stock frequently amounts to as much as $2 to $3 per 100 pounds. The low price for both sheep and lambs occurs in June, July, or August. This may be ascribed in part to the small quantity of wool carried by both sheep and lambs at this time. The peak of dressed-lamb prices is reached in April and May, whereas lowest prices are registered in October and November. These fluctuations correspond closely with the normal changes in market supplies. Feeder-lamb prices follow the trend of fat-lamb prices with a differential varying from a few cents above to as much as $2 below, depending on the relative demand from slaughterers and finishers.

Marketing Range Goats

Available Supply.—The census of 1925 showed 3,370,218 goats in the United States, 65 per cent of which were shorn in 1924. The 11 western range States had 824,543 head, 90 per cent of which were in Arizona, New Mexico, Oregon, and California. Texas leads in production with 53.2 per cent of all the goats in the United States, and

including these the range country has more than 77 per cent of the total supply. More than 80 per cent of the goats in the five leading range States, including Texas, were shorn in 1924. The estimated number of goats shorn in these five States in 1928 was 3,325,000 head. It is estimated that an average of 83,000 goats were slaughtered annually during the 5-year period, 1924–1928, 35 per cent of which were slaughtered under Federal inspection.

Markets and Demand.—The leading goat markets are Kansas City and Fort Worth, and the months of heaviest market receipts are May and June. During the rest of the year, receipts are so small as not to warrant regular quotations in market reports. The limited demand for goats at other markets makes it inadvisable to ship them in any great numbers. The average goat is not so well fleshed, is not capable of taking so high a finish, and does not give so high a dressing percentage as the average sheep. For this reason, goats sell at a considerable discount below sheep and lambs. Many consumers who are not familiar with the merits of goat meat discriminate against it in favor of lamb and mutton, but the leading goat-breed associations are endeavoring to popularize the meat by educational advertising. "Chevon," the name that has been selected for goat meat, has been officially recognized by the United States Department of Agriculture. There is a demand in some sections at times for both short-haired goats and Angora goats for use in clearing land and underbrush. Short-haired goats are often quoted in the market as "brushers." They usually sell for much less than fat Angoras. Practically the same procedure is followed when shipping goats as outlined for shipping sheep, the same rates and regulations applying.

Marketing Wool

Kinds and Grades of Western Wool.—*Sorting and grading.*—Wool produced in the United States is divided into two major groups—fleece or domestic wool and territory or staple wood. Fleece wools are those produced on farms in the Central and Eastern States, whereas territory wools are those grown on ranges in the Rocky Mountain region and on the Pacific slope. Territory wools comprise about 70 per cent of the total production of the United States. All wool, whether territory or domestic, is subjected to much additional subdividing or grouping in the course of marketing. Fleeces are graded largely on the basis of fineness or diameter of fiber. Sorting consists in picking out certain portions of the fleece because of their suitability for certain purposes, such suitability being determined largely by length of staple, kind and percentage of foreign material, and condition of wool with respect to matting and color. The grades of wool included in the official standards established and promulgated by the Secretary of Agriculture in an official order dated June 18, 1926, are: Fine, half-blood, three-eighths blood, quarter-blood, low-quarter blood, common, and braid. Each grade is determined by diameter of fiber. Information relative to these grades may be obtained by writing to the Bureau of Agricultural Economics, United States Department of Agriculture, Washington, D. C.

Shrinkage.—Shrinkage is the loss in weight resulting from the removal from wool of all foreign material, such as sand, dirt, grease, and burs. The percentage of shrinkage ranges from 20 to 80. It varies with the kind and grade of wool, with the area in which the wool is produced, with the season, from year to year, and with the general methods of handling before and after the wool is

shorn. Fine wool shrinks more than coarse wool and territory wools shrink more than fleece wool. Lower grades of territory wool shrink on an average from 50 to 60 per cent and the finer grades about 65 per cent. The percentage of shrinkage has much to do in determining the price of wool.

Handling Wool—*Preparation.*—Shear the sheep when the wool is absolutely dry—never when any moisture is in the fleece. The sheep should be shorn only on a smooth, dry surface, preferably a planed board flooring—never on the dirt. Care should be taken to keep the fleece intact. Avoid second cuts, which reduce the average length of the staple. Clip all tag-ends from each fleece and pack separately. Never permit them to remain in the fleece. The fleece should be prepared with the flesh side out—never the weather side. Fold, roll, or use a fleece box for preparing the fleece. Tie each fleece separately. Never tie two fleeces together or pack and market untied wool. Use only enough twine to tie the fleece securely. Paper or hard-glazed surface twine should be used. Never use sisal or binder twine. Never permit the fleece to come in contact with chaff, hay, dust, or any other foreign material. Place the tied fleeces in regulation woolsacks, or cover them with canvas or new burlap, if unable to sack them as shorn. Select a clean, dry place for storing the wool until it is sold. Never permit the wool to lie upon the ground and do not store in a basement. Keep white and black wool separate. Keep the burry, seedy, cotted, dead, black, and gray fleeces separate from the clean, well-grown wool, and pack separately. Never pack all grades together indiscriminately. Label wool bags both inside and out.

Shipping.—Where wool is sold locally, the buyer usually attends to all details of shipping and instructs the seller as to how, when, and where the wool is to be delivered. Likewise, when wool is shipped on consignment, whether to a cooperative pool, commission merchant, central market dealer, or direct to a manufacturer, such receiver usually will furnish shipping instructions if notified in advance of shipment.

Methods of Marketing Wool.—Most territory or range wool is marketed in one of the following five ways: (1) Direct to central market dealer, (2) by consigning to commission merchant, (3) through local wool pools, (4) through State or regional cooperative wool growers' association, or (5) direct to the manufacturer.

Central market dealer.—The central market dealer usually sends buyers into the range country to visit producers and purchase wool at the lowest price possible. Perhaps the chief advantage of this method consists in the fact that it gives free scope to the producer's trading instinct and ability. If he is a large producer, more buyers will naturally be anxious to purchase his wool than if he has only a small quantity to sell. Furthermore, if he is well informed on wool-market conditions and prices, he may be able to make a satisfactory deal with the buyer. If he is a small producer, he is not likely to obtain much competition for his wool, and if he he is not familiar with the latest developments, not only in the wool market of his own country but in the world market, he is likely to be at a disadvantage in trading with the more experienced buyer.

Consigning to a commission merchant.—In selling through a commission merchant the wool grower retains ownership of his wool and can set a price and hold it until that price is obtained. The commission merchant will grade it for him and is in position to show it to a

great many more prospective buyers than the producer could. In this way the producer can usually obtain a higher price than he could by selling to a dealer. However, there are certain charges for transportation, storage, insurance, grading, and selling which the producer must pay, and as a result of such payment his net returns may not be any greater than they would have been had he disposed of it by some other method.

Local wool pool.—If properly organized and managed, the local wool pool sometimes provides the grower with a good method of marketing his product. One of the chief advantages of this method, which is particularly well suited to the small-lot producer, is the fact that the grower gets more competition for his wool and usually gets the benefit of a certain amount of grading, which he either could not do for himself or which it would not pay him to attempt. The disadvantages of this method consist chiefly in the delays which are frequently involved in obtaining full payment for the wool and the grower's inability, under some circumstances, to obtain immediate advances of money which are frequently made by the commission merchant or the wool warehouse company. Most of these difficulties can be overcome if the pool is properly organized and managed.

Wool growers' association.—Marketing through a State or territory wool growers' association is similar to marketing through a local wool pool, except that the larger organization is likely to possess facilities for handling and disposing of wool which the smaller association does not have. More careful and satisfactory grading can usually be done, and, by virtue of the larger quantity of wool handled, such an organization can usually attract a larger number of prospective buyers. Better arrangements also can be made by such an organization to take care of the growers' immediate financial needs.

Selling wool direct to manufacturer.—The manufacturer sends his buyers direct to the producer, and the customary trade processes ensue. The advantages and disadvantages of this method are virtually the same as those outlined in connection with selling to a central-market dealer. In such transactions the success of the grower depends largely on his trading ability and his knowledge of general market and price conditions. The usual intermediate agencies are eliminated, but the grower should bear in mind that most of the services supplied by such agencies must be performed either by the grower himself or the manufacturer. If the latter supplies such services as sorting, grading, transportation, and financing, he must take those matters into account in fixing the price he will pay for the wool.

Variation of major methods.—All sorts of variations may occur in almost any of the methods of marketing outlined above. Some of these variations are caused by temporary changes in general economic conditions, and others are based largely on individual preference and fancy. For example, in times of wool scarcity, either immediate or prospective, manufacturers, brokers, commission merchants, and central-market dealers frequently send their agents into producing areas and contract for wool on the sheep's back. The agent usually agrees to take the producer's entire clip at a stipulated price per pound and sometimes advances to the grower immediately a portion of the agreed price. Such arrangements seldom work to the advantage of the producer for the reason that the buyer in most instances is in a better position than the seller to forecast accurately the future course of the market. Some growers dispose of their wool to either the agent of a manufacturer or to a central market dealer by having

a number of such agents inspect the wool and submit sealed bids, the grower reserving the right either to reject all bids or to sell to the highest bidder.

Wool Markets.—The leading wool markets of the United States are located near the centers of wool manufacturing and for that reason the largest markets are situated on the Atlantic seaboard. Boston is the greatest wool market in the United States, probably receiving more than 50 per cent of the annual production. Excluding carpet wool, practically none of which is produced in this country, the United States produces approximately 60 to 80 per cent of the wool it consumes, the rest coming from various foreign countries, principally Australia, New Zealand, Argentina, and South Africa. Of the foreign wool imported into the United States, more than half is received at Boston. Philadelphia is the next largest market. Other important markets are Chicago, New York, St. Louis, Portland, Oreg., and San Francisco.

Tariff on Wool.—The duties imposed on wool imported into the United States from any foreign country are indicated in the following paragraphs of the tariff act effective September 21, 1922.

Wools, not improved by the admixture of merino or English blood, such as Donskoi, native Smyrna, native South American, Cordova, Valparaiso, and other wools of like character or description, and hair of the camel, in the grease, 12 cents per pound; washed, 18 cents per pound; scoured, 24 cents per pound. The duty on such wools imported on the skin shall be 11 cents per pound: *Provided,* That such wools may be imported under bond in an amount to be fixed by the Secretary of the Treasury and under such regulations as he shall prescribe; and if within three years from the date of importation or withdrawal from bonded warehouse satisfactory proof is furnished that the wools have been used in the manufacture of rugs, carpets, or any other floor coverings, the duties shall be remitted or refunded: *Provided further,* That if any such wools imported under bond as above prescribed are used in the manufacture of articles other than rugs, carpets, or any other floor coverings, there shall be levied, collected, and paid on any wools so used in violation of the bond, in addition to the regular duties provided by this paragraph, 20 cents per pound, which shall not be remitted or refunded on exportation of the articles or for any other reason. Wools in the grease shall be considered such as shall have been shorn from the sheep without any cleansing; that is, in their natural condition. Washed wools shall be considered such as have been washed with water only on the sheep's back or on the skin.

Wools, not specially provided for, and hair of the Angora goat, Cashmere goat, alpaca, and other like animals, imported in the grease or washed, 31 cents per pound of clean content; imported in the scoured state, 31 cents per pound; imported on the skin, 30 cents per pound of clean content.

If any bale or package containing wools, hairs, wool wastes, or wool-waste material, subject to different rates of duty, be entered at any rate or rates lower than applicable, the highest rate applicable to any part shall apply to the entire contents of such bale or package.

Wool, and hair of the kinds provided for in this schedule, which has been advanced in any manner or by any process of manufacture beyond the washed or scoured condition, including tops, but not further advanced than roving, 33 cents per pound and 20 per cent ad valorem.

Marketing Mohair

Area of Production.—The production of mohair in the United States in 1928 amounted to approximately 14,522,000 pounds. The principal producing States are Texas, Oregon, Arizona, New Mexico, Missouri, and California.

Shearing.—In southern range States, goats are shorn twice a year—in March, immediately before kidding, and again six months later. Unless this is done, some hair is lost from shedding. In the North and Northwest the clip is taken off only in the spring. Machine shearing is practically a universal practice. Clipping is usually done on a table. The fleece is rolled, cut side out, but not tied. Texas hair generally goes to market in 5-foot bags, but farther west the 4-foot bag is common.

Grading.—The value of mohair depends upon its length, fineness, luster, density, and freedom from kemp. Most mohair is of the 6-months' clip and should be 6 inches long to comply with market requirements. A grade known as long mohair (over 12 inches) is grown under special conditions, the goats often carrying the fleece for 24 months. Long mohair is but a small percentage of the total clip. Kemp is coarse, shorter fiber, appearing on the shoulder, neck, rump, or along the back. Luster is that bright glossiness unique in mohair fabrics. Relative luster of fleece is to be distinguished only by the experienced eye. Fineness of mohair may be determined by the eye or by means of a mechanical device, but in practice it is associated with softness and is recognized by the experienced touch when handled between the thumb and fingers. Kid hair is finest and is especially desired by mills. The hair from does and young wethers ranks next. Buck fleeces are coarsest and grow more so with the age of the animals. Within each of these classes the market recognizes several grades. The grower, as far as possible, should grade his product systematically. Fleeces should be rolled up to prevent the mixing of the mohair of different fleeces. When packing the clip for market, keep the kid fleeces separate from those of the mature goats and the buck fleeces by themselves. Fleeces that are extremely coarse, shorter than 6 inches, and weak, or those having an excess of kemp and burs or other foreign material, should be kept separate from clean, strong fleeces of desirable length and fineness.

Marketing Methods.—The same agencies which handle wool usually handle mohair, and the same general methods of buying and selling are used.

AGRICULTURAL FINANCE

Farm credit may be grouped under several classifications. When based on the nature of the security, it is known as either mortgage credit or personal and collateral credit. If classified according to purpose or use, it is designated as land-purchase credit, development and equipment credit, and production and marketing credit. Under a third grouping based on the period of time for which it is required, farm credit may be classed as long-term credit covering a period of 3 to 40 years, intermediate credit of 6 months to 3 years, and short-term credit of 6 months or less. The classes based on term correspond roughly to the three classes based on purpose of use.

Farm-Mortgage Credit

Leading sources of farm-mortgage credit are local banks, life-insurance companies, farm-mortgage companies, State funds or special State credit agencies, private individuals, and the land banks operating under the Federal farm loan act.

Under the Federal farm loan act loans are made on farm real estate by both Federal land banks and joint-stock land banks.

Federal land banks may make maximum loans of $25,000 to actual farmers. These loans are secured by first mortgages on farm real estate up to 50 per cent of the appraised value of the land, plus 20 per cent of the appraised value of the permanent improvements.

Federal land-bank loans are usually obtained through national farm-loan associations. These corporations are chartered by the Federal Farm Loan Board and may be organized by 10 or more farmers who desire total loans of not less than $20,000. The executive officer is the secretary-treasurer who acts as agent for the local association in its relations with the Federal land bank. Every farmer who obtains a loan is required to buy stock of his local association equal to 5 per cent of his loan. The association may declare dividends to shareholders after meeting certain requirements as to reserves. Every member is liable to twice the amount of his stock for losses which the local association may sustain.

The maximum interest rate is 6 per cent. The rate charged by the banks is governed by the interest rate that must be paid on funds obtained for lending purposes. In no case can the interest rate on Federal farm loans exceed by more than 1 per cent per annum the interest paid on the last issue of Federal land-bank bonds. At the present time (January, 1925) the interest rate on Federal farm loans is 5½ per cent.

Loans may run from 5 to 40 years at the option of the borrower. Most loans are made for 35 years. Payments covering the annual interest and 1 per cent per year applied on the principal will wipe out the debt in 35 years. Payments are made semiannually. After they have run five years loans may be repaid in full or in part on any interest-paying date.

The funds used in making farm loans are obtained chiefly from the sale of bonds which are secured by the mortgages taken for the loans. These bonds are well secured and can be recommended for investment purposes.

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They may be purchased directly from the land banks through the local national farm-loan associations and through other local representatives of the land banks.

The system under which the joint-stock land banks operate is very similar to that of Federal land banks. The following special features are of interest. The joint-stock land banks may make maximum loans of $50,000 to both actual farmers and other owners of farm land. Loans may be obtained directly from the bank or through its local agent. No investment in the stock of the bank is required, nor does special liability attach to the borrower for losses incurred on other loans. The maximum interest rate is 6 per cent, which is the rate now charged by most of the joint-stock land banks.

Intermediate Credit

The term "intermediate credit" is applied to loans made to farmers on personal and collateral security for periods ranging from six months to three years.

The agricultural credits act of 1923, which makes special provision for farm credit of this kind, established 12 intermediate-credit banks. These banks are located in the same cities as the Federal land banks, serve the same districts, and have the same officers and directors. They operate under the supervision of the Federal Farm Loan Board.

The intermediate-credit banks provide farm credit in two ways: First, by discounting farm paper for local banks, livestock-loan companies, and other institutions which supply farm credit; and secondly, by direct advances to cooperative-marketing associations. They do not lend directly to farmers.

Individual farmers may obtain the discount benefits of the system through their local banks or by the organization of local agricultural-credit corporations, if adequate accommodation is not supplied by already established credit institutions. Under the act these corporations may be established by any group of citizens. They must be incorporated under State law and have a minimum capital of $10,000 in order to obtain the rediscount privilege. Rediscounts may be made up to ten times the capital and surplus of the corporation. Discount rates charged by the intermediate-credit banks may not exceed by more than 1 per cent the interest rate paid on the last debentures sold. On the other hand, the interest rate charged to borrowers by banks and other credit institutions which rediscount their paper with the intermediate-credit banks, can not exceed, except by special ruling of the board, the discount rate by more than 1½ per cent.

Cooperative-marketing associations may obtain direct advances secured by warehouse receipts on staple agricultural products. The following commodities, when properly stored, have been approved to date as acceptable security for loans: Grain, cotton, wool, tobacco, peanuts, broomcorn, beans (including soy beans), rice, alfalfa and redtop clover seeds, hay, nuts, dried prunes, dried raisins, and canned fruits and vegetables. Direct loans to cooperative-marketing associations are made at interest rates which must not exceed by more than 1 per cent the rate paid on the last issue of intermediate-credit debentures. At the present time (January, 1925) the interest rate on loans to cooperative-marketing associations is 4½ per cent.

Funds for lending purposes are obtained from the capital subscribed by the United States Treasury and by the sale of short-term debentures running from six months to three years. These debentures are well secured and are recommended for investment purposes.

Location and districts of Federal land banks and Federal intermediate-credit banks

Location	States in each district
(1) Springfield, Mass.	Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey.
(2) Baltimore	Pennsylvania, Virginia, West Virginia, Maryland, Delaware, District of Columbia.
(3) Columbia	North Carolina, South Carolina, Georgia, Florida.
(4) Louisville	Tennessee, Kentucky, Indiana, Ohio.
(5) New Orleans	Alabama, Louisiana, Mississippi.
(6) St. Louis	Illinois, Missouri, Arkansas.
(7) St. Paul	North Dakota, Minnesota, Wisconsin, Michigan.
(8) Omaha	Iowa, Nebraska, South Dakota, Wyoming.
(9) Wichita	Kansas, Oklahoma, Colorado, New Mexico.
(10) Houston	Texas.
(11) Berkeley	California, Utah, Nevada, Arizona.
(12) Spokane	Idaho, Montana, Oregon, Washington.

A loan of $1,000 at 5½ per cent interest repayable in 34½ years by means of semiannual installments of $32.50, which includes interest and part of the principal

Payment number	Installment	Interest	Applied on principal	Principal still unpaid
1	$32. 50	$27. 50	$5. 00	$995. 00
2	32. 50	27. 36	5. 14	989. 86
3	32. 50	27. 22	5. 28	984. 58
4	32. 50	27. 08	5. 42	979. 16
5	32. 50	26. 93	5. 57	973. 59
6	32. 50	26. 77	5. 73	967. 86
7	32. 50	26. 62	5. 88	961. 98
8	32. 50	26. 45	6. 05	955. 93
9	32. 50	26. 29	6. 21	949. 72
10	32. 50	26. 12	6. 38	943. 34
11	32. 50	25. 94	6. 56	936. 78
12	32. 50	25. 76	6. 74	930. 04
13	32. 50	25. 58	6. 92	923. 12
14	32. 50	25. 39	7. 11	916. 01
15	32. 50	25. 19	7. 31	908. 70
16	32. 50	24. 99	7. 51	901. 19
17	32. 50	24. 78	7. 72	893. 47
18	32. 50	24. 57	7. 93	885. 54
19	32. 50	24. 35	8. 15	877. 39
20	32. 50	24. 13	8. 37	869. 02
21	32. 50	23. 90	8. 60	860. 42
22	32. 50	23. 66	8. 84	851. 58
23	32. 50	23. 42	9. 08	842. 50
24	32. 50	23. 17	9. 33	833. 17

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A loan of $1,000 at 5½ per cent interest repayable in 34½ years by means of semiannual installments of $32.50, which includes interest and part of the principal—Continued

Payment number	Installment	Interest	Applied on principal	Principal still unpaid
25	$32.50	$22.91	$9.59	$823.58
26	32.50	22.65	9.85	813.73
27	32.50	22.38	10.12	803.61
28	32.50	22.10	10.40	793.21
29	32.50	21.81	10.69	782.52
30	32.50	21.52	10.98	771.54
31	32.50	21.22	11.28	760.26
32	32.50	20.91	11.59	748.67
33	32.50	20.59	11.91	736.76
34	32.50	20.26	12.24	724.52
35	32.50	19.92	12.58	711.94
36	32.50	19.58	12.92	699.02
37	32.50	19.22	13.28	685.74
38	32.50	18.86	13.64	672.10
39	32.50	18.48	14.02	658.08
40	32.50	18.10	14.40	643.68
41	32.50	17.70	14.80	628.88
42	32.50	17.29	15.21	613.67
43	32.50	16.88	15.62	598.05
44	32.50	16.45	16.05	582.00
45	32.50	16.01	16.49	565.51
46	32.50	15.55	16.95	548.56
47	32.50	15.09	17.41	531.15
48	32.50	14.61	17.89	513.26
49	32.50	14.11	18.39	494.87
50	32.50	13.61	18.89	475.98
51	32.50	13.09	19.41	456.57
52	32.50	12.56	19.94	436.63
53	32.50	12.01	20.49	416.14
54	32.50	11.44	21.06	395.08
55	32.50	10.86	21.64	373.44
56	32.50	10.27	22.23	351.21
57	32.50	9.66	22.84	328.37
58	32.50	9.03	23.47	304.90
59	32.50	8.38	24.12	280.78
60	32.50	7.72	24.78	256.00
61	32.50	7.04	25.46	230.54
62	32.50	6.34	26.16	204.38
63	32.50	5.62	26.88	177.50
64	32.50	4.88	27.62	149.88
65	32.50	4.12	28.38	121.50
66	32.50	3.34	29.16	92.34
67	32.50	2.54	29.96	62.38
68	32.50	1.72	30.78	31.60
69	32.47	.87	31.60	----------
Total	2,242.47	1,242.47	1,000.00	----------

A loan of $1,000 bearing 6 per cent interest payable in 33 years in semiannual installments of $35 each, which includes interest and part of the principal

Payment number	Install-ment	Interest	Applied on prin-cipal	Principal still unpaid
1	$35.00	$30.00	$5.00	$995.00
2	35.00	29.85	5.15	989.85
3	35.00	29.70	5.30	984.55
4	35.00	29.53	5.47	979.08
5	35.00	29.37	5.63	973.45
6	35.00	29.21	5.79	967.66
7	35.00	29.03	5.97	961.69
8	35.00	28.85	6.15	955.54
9	35.00	28.66	6.34	949.20
10	35.00	28.48	6.52	942.68
11	35.00	28.28	6.72	935.96
12	35.00	28.08	6.92	929.04
13	35.00	27.87	7.13	921.91
14	35.00	27.66	7.34	914.57
15	35.00	27.44	7.56	907.01
16	35.00	27.21	7.79	899.22
17	35.00	26.97	8.03	891.19
18	35.00	26.74	8.26	882.93
19	35.00	26.49	8.51	874.42
20	35.00	26.23	8.77	865.65
21	35.00	25.97	9.03	856.62
22	35.00	25.70	9.30	847.32
23	35.00	25.42	9.58	837.74
24	35.00	25.13	9.87	827.87
25	35.00	24.83	10.17	817.70
26	35.00	24.53	10.47	807.23
27	35.00	24.22	10.78	796.45
28	35.00	23.90	11.10	785.35
29	35.00	23.56	11.44	773.91
30	35.00	23.21	11.79	762.12
31	35.00	22.87	12.13	749.99
32	35.00	22.50	12.50	737.49
33	35.00	22.12	12.88	724.61
34	35.00	21.74	13.26	711.35
35	35.00	21.34	13.66	697.69
36	35.00	20.93	14.07	683.62
37	35.00	20.51	14.49	669.13
38	35.00	20.07	14.93	654.20
39	35.00	19.63	15.37	638.83
40	35.00	19.16	15.84	622.99
41	35.00	18.69	16.31	606.68
42	35.00	18.20	16.80	589.88
43	35.00	17.70	17.30	572.58
44	35.00	17.18	17.82	554.76
45	35.00	16.64	18.36	536.40
46	35.00	16.09	18.91	517.49
47	35.00	15.53	19.47	498.02
48	35.00	14.94	20.06	477.96
49	35.00	14.34	20.66	457.30
50	35.00	13.72	21.28	436.02
51	35.00	13.08	21.92	414.10
52	35.00	12.42	22.58	391.52
53	35.00	11.74	23.26	368.26
54	35.00	11.05	23.95	344.31
55	35.00	10.33	24.67	319.64

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A loan of $1,000 bearing 6 per cent interest payable in 33 years in semiannual installments of $35 each, which includes interest and part of the principal—Continued

Payment number	Install-ment	Interest	Applied on prin-cipal	Principal still unpaid
56	$35.00	$9.59	$25.41	$294.23
57	35.00	8.83	26.17	268.06
58	35.00	8.04	26.96	241.10
59	35.00	7.23	27.77	213.33
60	35.00	6.40	28.60	184.73
61	35.00	5.54	29.46	155.27
62	35.00	4.66	30.34	124.93
63	35.00	3.75	31.25	93.68
64	35.00	2.81	32.19	61.49
65	35.00	1.85	33.15	28.34
66	29.19	.85	28.34	----------
Total	2,304.19	1,304.19	1,000.00	----------

Statement showing loans closed by Federal and joint-stock land banks from organization to December 31, 1924, and life-insurance company farm loans outstanding in 1923, by States

State	Loans closed by Federal land banks [1]		Loans closed by joint-stock land banks [1]		Life-insurance company farm loans outstanding 1923 [2]
	Number	Amount	Number	Amount	Amount
Maine	2,243	$6,306,150	------	----------	$1,800
New Hampshire	469	1,051,975	------	----------	----------
Vermont	911	2,495,100	------	----------	4.550
Massachusetts	1,359	3,728,005	------	----------	25,100
Rhode Island	113	351,650	------	----------	----------
Connecticut	1,178	3,962,250	------	----------	21,300
New York	5,073	16,906,640	688	$4,520,100	69,650
New Jersey	953	3,734,550	200	1,108,900	688,150
Virginia	9,856	27,333,233	758	4,944,200	4,581,462
Maryland	907	3,569,500	176	1,228,900	39,500
Delaware	92	310,600	------	----------	----------
Pennsylvania	4,461	12,015,300	855	3,672,300	45,750
West Virginia	2,743	5,569,550	1,487	5,181,550	8,000
North Carolina	9,371	19,050,350	4,216	16,463,400	10,682,745

[1] From Federal Farm Loan Bureau, Treasury Department.
[2] Statement issued by Bankers' Life Insurance Co ; statistics are based on reports from 52 life-insurance companies having assets amounting to 93.13 per cent of the total assets of all United States legal-reserve life-insurance companies, Dec. 31, 1923.

Statement showing loans closed by Federal and joint-stock land banks from organization to December 31, 1924, and life-insurance company farm loans outstanding in 1923, by States—Contd.

State	Loans closed by Federal land banks		Loans closed by joint-stock land banks		Life-insurance company farm loans outstanding 1923
	Number	Amount	Number	Amount	Amount
South Carolina	5, 993	$17, 224, 670	1, 314	$7, 209, 000	$9, 486, 091
Georgia	8, 627	20, 707, 010	490	2, 592, 700	42, 018, 612
Florida	3, 546	6, 610, 169	------	-----------	550, 057
Tennessee	8, 789	22, 695, 500	671	3, 004, 600	32, 258, 432
Kentucky	6, 940	22, 807, 100	1, 782	11, 322, 300	17, 766, 023
Indiana	9, 611	35, 155, 200	5, 709	33, 311, 084	93, 442, 300
Ohio	4, 741	18, 896, 800	4, 172	21, 406, 100	39, 547, 829
Alabama	17, 482	32, 770, 470	300	2, 518, 900	10, 883, 654
Louisiana	10, 638	26, 097, 765	30	556, 000	7, 105, 041
Mississippi	22, 256	42, 854, 920	285	4, 927, 500	22, 414, 543
Illinois	5, 311	24, 223, 105	6, 271	53, 427, 045	107, 529, 711
Missouri	8, 371	26, 828, 960	3, 073	25, 317, 660	122, 312, 031
Arkansas	14, 044	23, 955, 710	817	8, 301, 700	16, 054, 395
North Dakota	10, 395	40, 546, 000	774	4, 584, 600	31, 638, 291
Minnesota	9, 024	38, 752, 200	4, 075	36, 565, 050	116, 496, 565
Wisconsin	7, 143	27, 777, 000	1, 034	5, 167, 850	7, 489, 465
Michigan	8, 015	20, 365, 000	745	3, 845, 400	2, 569, 258
Iowa	7, 260	54, 515, 950	6, 466	82, 787, 295	404, 137, 553
Nebraska	7, 963	40, 841, 990	2, 389	23, 884, 290	121, 034, 342
South Dakota	5, 125	24, 152, 250	1, 500	12, 745, 820	88, 539, 761
Wyoming	2, 322	7, 063, 400	503	4, 083, 600	234, 686
Kansas	9, 484	39, 816, 550	3, 809	26, 260, 700	131, 758, 062
Oklahoma	6, 928	18, 756, 100	997	5, 861, 250	64, 227, 999
Colorado	8, 258	24, 051, 500	167	1, 268, 000	3, 129, 328
New Mexico	5, 043	10, 622, 700	------	-----------	2, 120, 483
Texas	38, 417	112, 330, 691	4, 897	41, 276, 811	99, 009, 951
California	7, 077	25, 414, 600	1, 241	16, 090, 900	12, 122, 165
Utah	4, 827	15, 433, 500	132	688, 500	657, 358
Nevada	205	781, 000	21	374, 700	80, 000
Arizona	1, 318	5, 402, 600	201	1, 459, 200	1, 469, 028
Idaho	7, 156	25, 525, 795	411	2, 112, 900	9, 009, 090
Montana	7, 890	23, 260, 990	348	2, 075, 900	8, 875, 251
Oregon	6, 697	22, 458, 980	769	9, 215, 400	7, 212, 401
Washington	11, 662	32, 073, 420	163	1, 835, 700	13, 047, 401
Porto Rico	1, 683	4, 846, 700	------	-----------	--------------
Total	339, 970	1, 042, 001, 148	63, 936	493, 197, 805	[3] 1, 662, 761, 125

[3] Includes $385,961 classified as miscellaneous.

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2.5

Interest rates on first-mortgage farm loans, 1923

State	Commercial banks	Life-insurance companies	Federal land banks	
			To June 1	After June 1
	Per cent	*Per cent*	*Per cent*	*Per cent*
New England	5. 92	----------	6. 00	5. 50
Maine	6. 20	----------	6. 00	5. 50
New Hampshire	5. 31	----------	6. 00	5. 50
Vermont	6. 03	----------	6. 00	5. 50
Massachusetts	5. 91	6. 00	6. 00	5. 50
Rhode Island	6. 00	----------	6. 00	5. 50
Connecticut	5. 98	----------	6. 00	5. 50
Middle Atlantic	5. 98	----------	6. 00	5 50
New York	5. 97	6. 00	6. 00	5. 50
New Jersey	5. 98	7. 50	6. 00	5. 50
Pennsylvania	5. 98	----------	6. 00	5. 50
East North Central	6. 37	----------	6. 00	5. 50
Ohio	6. 38	5. 30	6. 00	5. 50
Indiana	6. 56	5. 24	6. 00	5. 50
Illinois	6. 19	5. 09	6. 00	5. 50
Michigan	6. 69	5. 17	6. 00	5. 50
Wisconsin	6. 20	5. 13	6. 00	5. 50
West North Central	6. 88	----------	6. 00	5. 50
Minnesota	6. 57	5. 24	6. 00	5. 50
Iowa	6, 24	5, 15	6. 00	5. 50
Missouri	7, 03	5. 28	6. 00	5. 50
North Dakota	8. 01	6. 11	6. 00	5. 50
South Dakota	7. 18	5. 29	6. 00	5. 50
Nebraska	6. 83	5. 24	6. 00	5. 50
Kansas	7. 24	5. 25	6. 00	5. 50
South Altantic	6. 84	----------	6. 00	5. 50
Delaware	6. 00	----------	6. 00	5. 50
Maryland	5. 99	----------	6. 00	5. 50
Virginia	6, 13	5. 36	6. 00	5. 50
West Virginia	6. 06	----------	6. 00	5. 50
North Carolina	6. 12	5. 49	6. 00	5. 50
South Carolina	7. 88	5. 95	6. 00	5. 50
Georgia	8. 10	6. 27	6. 00	5. 50
Florida	8. 14	7. 19	6. 00	5. 50
East South Central	7. 21	----------	6. 00	5. 50
Kentucky	6. 40	5. 34	6. 00	5. 50
Tennessee	7. 39	5. 50	6. 00	5. 50
Alabama	8. 04	6. 18	6. 00	5. 50
Mississippi	7. 95	6. 21	6. 00	5. 50
West South Central	8. 92	----------	6. 00	5. 50
Arkansas	9. 20	6. 56	6. 00	5. 50
Louisiana	7. 99	6. 12	6. 00	5. 50
Oklahoma	9. 09	5. 55	6. 00	5. 50
Texas	8. 77	6. 35	6. 00	5. 50
Mountain	8. 82	----------	6. 00	5. 50
Montana	9. 08	6. 82	6. 00	5. 50
Idaho	8. 79	6. 43	6. 00	5. 50
Wyoming	8. 95	----------	6. 00	5. 50
Colorado	8. 78	7. 07	6. 00	5. 50
New Mexico	9. 64	8. 48	6. 00	5. 50
Arizona	8, 81	7. 28	6. 00	5. 50
Utah	8. 11	6. 74	6. 00	5. 50
Nevada	8. 00	----------	6. 00	5. 50
Pacific	7. 39	----------	6. 00	5. 50
Washington	7. 81	5. 52	6. 00	5. 50
Oregon	7. 78	5. 62	6. 00	5. 50
California	7. 12	7. 02	6. 00	5. 50
United States	6. 89	5. 36	6. 00	5. 50

Statement of rediscounts, direct loans, and advances upon the respective commodities of the 12 Federal intermediate-credit banks as of May 29, 1926

Bank at—	Direct loans	Rediscounts	Total
(1) Springfield, Mass.	$4,150,000.00	$159,300.00	$4,309,300.00
(2) Baltimore	7,077,900.00	620,545.20	7,698,445.20
(3) Columbia	2,656,535.98	13,913,510.42	16,570,046.40
(4) Louisville	1,653,908.46	638,122.74	2,292,031.20
(5) New Orleans	4,569,997.00	3,669,619.07	8,239,616.07
(6) St. Louis	2,965,862.29	1,692,572.56	4,658,434.85
(7) St. Paul	444,040.02	3,247,565.23	3,691,605.25
(8) Omaha	326,038.69	4,714,627.78	5,040,666.47
(9) Wichita	3,145,500.00	1,821,756.46	4,967,256.46
(10) Houston	5,500,000.00	5,910,077.40	11,410,077.40
(11) Berkeley	4,130,925.29	2,596,842.40	6,727,767.69
(12) Spokane	270,295.82	2,802,397.64	3,072,693.46
Total	36,891,003.55	41,786,936.90	78,677,940.45

Classification of rediscounts

Agricultural-credit corporations	$28,625,521.05
State banks	480,144.22
National banks	3,171.29
Livestock-loan companies	12,678,100.34

Classification of direct loans

Tobacco	$12,585,423.88	Wool	$453,834.51
Wheat	180,924.60	Cotton	18,414,997.00
Canned fruit and vegetables	450,487.79	Grimm alfalfa seed	67,500.00
Raisins	3,600,000.00	Rice	911,299.79
Peanuts	31,535.98	Coffee	195,000.00

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Fire Insurance

Statistical summary of farmers' mutual fire insurance, by States, 1921

State	Companies	Value of insurable farm property	Insurable farm property insured	Risk in force Dec. 31, 1921	Cost per $100 per year
	Number	*Million dollars*	*Per cent*	*Million dollars*	*Cents*
Maine	50	176	32.4	57	[1] 45
New Hampshire	20	76	13.2	10	44
Vermont	1	149	1.3	2	7
Massachusetts	5	184	16.9	31	37
Rhode Island	2	20	5.0	1	25
Connecticut	8	135	83.7	113	33
New York	137	1,199	57.0	541	31
New Jersey	13	187	59.9	84	36
Pennsylvania	200	1,085	91.0	987	[2] 27
Ohio	117	1,202	68.8	621	21
Indiana	72	939	52.4	369	25
Illinois	216	1,589	35.2	419	[1] 22
Michigan	81	885	84.1	744	54
Wisconsin	204	1,147	99.4	855	18
Minnesota	161	1,138	80.2	685	16
Iowa	152	2,024	49.8	755	21
Missouri	101	1,109	35.4	295	28
North Dakota	41	541	24.2	99	26
South Dakota	43	655	20.8	102	17
Nebraska	69	975	79.5	581	17
Kansas	20	945	42.2	300	27
Delaware	3	43	55.8	18	[3] 24
Maryland	15	226	61.1	103	38
District of Columbia	--------	2	--------	--------	--------
Virginia	34	499	24.7	92	26
West Virginia	11	208	22.1	35	29
North Carolina	9	493	10.0	37	30
South Carolina	14	393	10.7	32	71
Georgia	5	567	1.4	5	[1] 61
Florida	--------	118	--------	--------	--------
Kentucky	19	531	10.6	42	49
Tennessee	34	508	14.0	53	55
Alabama	1	336	.3	1	2
Mississippi	--------	390	--------	--------	--------
Arkansas	10	385	3.4	10	40
Louisiana	--------	247	--------	--------	--------
Oklahoma	5	599	1.8	8	42
Texas	19	1,417	4.9	51	57
Montana	11	308	3.3	7	35

[1] 1920 figures; later figures not at hand.
[2] Estimated on the basis of 1917 figures, by allowing the percentage of increase found for the two other Middle Atlantic States. No reports issued since 1917.
[3] 1919 figures; later figures not complete.

Statistical summary of farmers' mutual fire insurance, by States, 1921—Continued

State	Companies	Value of insurable farm property	Insurable farm property insured	Risk in force Dec. 31, 1921	Cost per $100 per year
	Number	*Million dollars*	*Per cent*	*Million dollars*	*Cents*
Idaho	9	230	13.0	22	38
Wyoming	2	130	.8	1	12
Colorado	4	349	12.6	33	25
New Mexico		137			
Arizona		86			
Utah	1	112	2.7	2	18
Nevada		43			
Washington	6	305	14.8	34	29
Oregon	6	259	43.2	84	38
California	21	766	15.5	89	38
United States	1,952	26,047	40.4	8,411	27

Fire Insurance on Farm Property.—Fire causes heavy annual destruction of farm property. As a matter of sound business policy, therefore, every farmer should carry insurance against such losses.

Commercial insurance companies write the bulk of insurance carried on farm buildings. The efficiency of farmers' mutual fire-insurance companies, however, has been fully demonstrated, and the volume of insurance written by farmers' companies is expanding. At the close of the year, 1921, there were, according to the best figures available, 1,952 farmers' mutual insurance companies, which had risks in force of about $8,411,000,000. These farmers' companies carried somewhat over 5 per cent of the total fire-insurance risks in the United States.

The average annual cost of insurance carried in farmers' mutual companies is between 25 and 30 cents a year for each $100. This cost is materially lower than that of the commercial insurance companies.

The low cost in farmers' mutuals is made possible in part by elimination of many of the expenses incident to operation of larger companies on a commercial plan, but even more to a reduction of fire losses by the practical elimination of the moral hazard and the removal of needless fire dangers from the insured property. This loss prevention is accomplished through a more careful inspection of insured property, the insistence upon necessary improvements, the avoidance of overinsurance, and also to an increasing extent, through the classification of property, by which precaution against fire dangers is rewarded in the assessment rates.

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Taxation

General property taxes paid by farmers, 1914, 1917, 1919–1923

[000,000 omitted]

	Year collected						
	1914	1917	1919	1920	1921	1922	1923
Amount	$344	$364	$448	$532	$746	$799	$845

Real and personal property taxes paid by farmers from 1914 to 1923, shown above, were estimated by the United States Department of Agriculture from statements of crop reporters.

Property Taxes on Farm Real Estate.—The tax per acre on farm real estate in the years 1914 and 1922 illustrates the way in which taxes have increased throughout the country. Generally speaking, farm taxes per acre are highest in the Middle Atlantic and North Central States and lowest in the South Atlantic and Mountain States.

Property taxes on farm real estate, by States, 1913–14, 1921–22

State	Number of farms reported	Taxes on farm lands per acre [1]		1921–22 per cent of 1913–14 [1]
		1913–14	1921–22	
Maine	65	$0.35	$0.60	172
New Hampshire	23	.36	.67	189
Vermont	30	.35	.65	187
Massachusetts	37	.63	1.20	189
Rhode Island [2]	5	.59	.99	168
Connecticut	17	.50	.99	196
New York	144	.59	1.13	194
New Jersey [2]	18	.96	2.22	232
Pennsylvania	138	.58	1.11	192
Delaware	9	.37	.68	182
Maryland	41	.50	.85	170
Virginia	121	.20	.34	176
West Virginia [2]	41	.21	.52	247
North Carolina	104	.16	.44	269
South Carolina	74	.13	.35	262
Georgia	82	.16	.30	188
Florida	34	.28	.65	229
Ohio	212	.61	1.24	204
Indiana	202	.67	1.60	238
Illinois	236	.56	1.23	222
Michigan	135	.66	1.58	240
Wisconsin	156	.55	1.23	224
Minnesota	98	.37	.91	246
Iowa	77	.68	1.49	220
Missouri	96	.17	.39	225
North Dakota	58	.24	.63	258
South Dakota	65	.27	.80	292
Nebraska	89	.27	.67	249
Kansas	113	.27	.63	229

[1] Computed from totals for farms reported in each State.
[2] Reports so few or conflicting as to be of doubtful value.

Property taxes on farm real estate, by States, 1913–14, 1921–22—Continued

State	Number of farms reported	Taxes on farm lands per acre		1921–22 per cent of 1913–14
		1913–14	1921–22	
Kentucky	82	$0.24	$0.52	215
Tennessee	151	.19	.53	271
Alabama	73	.13	.25	192
Mississippi	104	.26	.67	259
Louisiana [2]	21	.29	.77	257
Texas	83	.17	.35	214
Oklahoma	91	.28	.57	201
Arkansas	45	.16	.39	243
Montana [2]	11	.07	.16	240
Wyoming [2]	12	.19	.39	204
Colorado	18	.20	.68	340
New Mexico [2]	11	.19	.33	172
Arizona [2]	3	.07	.07	100
Utah	12	.24	.42	176
Nevada [2]	4	.21	.43	205
Idaho	19	.59	1.40	235
Washington	28	.33	.70	215
Oregon	12	.27	.78	290
California	38	.42	.78	187

[2] Reports so few or conflicting as to be of doubtful value.

Distribution of income-tax returns filed by corporations engaged in agriculture, showing corporations reporting net incomes and those reporting no net income for the calendar year 1921, by States and Territories [1]

[Thousand dollars, i. e., 000 omitted]

State or Territory	Total number of corporations	Corporations reporting net income					Corporations reporting no net income	
		Number	Net income	Income tax	War-profits and excess-profits tax	Total tax	Number	Deficit
Ala	58	31	$89	$5	$9	$15	27	$275
Alaska	1	1	1	1		1		
Ariz	103	14	62	4	3	7	89	1,937
Ark	124	57	337	21	45	65	67	562
Calif	1,152	465	5,465	429	462	892	687	11,376
Colo	251	57	283	23	10	33	194	2,261
Conn	60	28	270	24	10	34	32	561
Del	25	6	5				19	685
D. C	8	3	44	4	2	7	5	6
Fla	199	66	386	31	16	47	133	1,298
Ga	162	57	98	4		4	105	663
Hawaii	70	24	2,057	189	128	317	46	3,602
Idaho	110	23	45	2		2	87	2,795

[1] From Bureau of Internal Revenue.

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Distribution of income-tax returns filed by corporations engaged in agriculture, showing corporations reporting net incomes and those reporting no net income for the calendar year 1921, by States and Territories—Continued.

[Thousand dollars, i. e., 000 omitted]

State or Territory	Total number of corporations	Corporations reporting net income					Corporations reporting no net income	
		Number	Net income	Income tax	War profits and excess profits tax	Total tax	Number	Deficit
Ill.	194	97	$366	$26	$8	$34	97	$1, 160
Ind.	102	42	108	6	2	8	60	346
Iowa	106	54	247	21	9	30	52	354
Kans.	33	12	17	1	1	1	21	445
Ky.	24	8	3	-------	-------	-------	16	165
La.	252	78	210	11	8	20	174	4, 076
Maine	43	17	40	2	1	4	26	100
Md.	51	16	138	14	(2)	14	35	210
Mass.	185	91	15, 955	1, 473	1, 029	2, 502	94	742
Mich.	176	72	995	81	49	130	104	523
Minn.	107	31	142	9	5	14	76	1, 004
Miss.	69	46	113	4	3	7	23	269
Mo.	146	44	386	33	29	61	102	792
Mont.	283	52	89	4	(2)	4	231	3, 130
Nebr.	93	33	208	9	5	14	60	986
Nev.	68	11	48	3	2	5	57	1, 683
N. H.	9	5	10	(2)	-------	(2)	4	8
N. J.	112	57	413	29	51	80	55	724
N. Mex.	95	16	103	9	1	9	79	1, 681
N. Y.	298	128	2, 011	176	180	356	170	3, 451
N. C.	94	43	93	4	4	8	51	321
N. Dak.	79	10	5	-------	-------	-------	69	369
Ohio	183	64	366	24	34	57	119	1, 224
Okla.	76	33	92	4	5	[illegible]	43	421
Oreg.	224	58	161	10	4	14	166	1, 688
Pa.	124	45	365	30	11	41	79	672
R. I.	9	5	10	(2)	-------	(2)	4	48
S. C.	110	47	56	2	-------	2	63	419
S. Dak.	47	11	35	1	-------	1	36	308
Tenn.	82	43	226	16	(2)	17	39	470
Tex.	462	233	1, 123	81	61	142	229	1, 931
Utah	174	51	67	3	(2)	3	123	1, 169
Vt.	7	1	3	(2)	-------	(2)	6	104
Va.	107	25	41	1	1	2	82	505
Wash.	326	119	393	25	8	33	207	1, 625
W. Va.	79	15	46	2	1	4	64	322
Wis.	199	76	349	25	22	46	123	795
Wyo.	277	63	92	2	(2)	2	214	3, 074
Total	7, 428	2, 684	34, 266	2, 878	2, 221	5, 100	4, 744	63, 334

[2] Less than $500.

AGRICULTURAL ORGANIZATIONS

Cooperative Associations

Fundamentals of Cooperation.—The success with which a cooperative organization functions depends on the observance of certain principles derived from the experience of cooperators. The following factors have been found to be the most important and to have the most general application:

(1) A cooperative organization must be controlled by its members, not as shareholders or investors, but as producers employing the facilities of the organization.

(2) A cooperative association is not operated to make a profit above the usual rate of interest on invested capital but to market profitably the products of its members.

(3) A cooperative association should be organized around a single commodity or a group of commodities for which the same market machinery, methods, and channels are employed.

(4) The organization should have sufficient business to enable it to operate efficiently and should control this business through definite legal contracts with its members.

(5) The organization must perform definite functions. Cooperative marketing is not an end in itself.

(6) The members must understand the purpose of the organization and be fully informed regarding its activities and problems.

(7) A cooperative association should have expert management. The duties of the manager of a cooperative association are more difficult than those of the manager of a commercial enterprise of equal size. The manager must not only conduct the business of the organization efficiently, but he must recognize the close personal interest of every member in that business and be able to maintain harmonious contacts with each individual.

(8) Proper accounting is essential. Accounting is one phase of management that is so important in cooperative marketing that it is given special mention. The management can not be properly advised regarding the status of the organization or properly inform the members without accurate records.

(9) Sound financial policies are also a part of the management, but are of sufficient importance to be placed under a separate heading. One essential is that a cooperative association should build up adequate reserves in order that it may have the financial strength necessary to weather periods of stress.

(10) A cooperative organization should be self-perpetuating. It should have a definite legal status, and once it is organized it should never be necessary to call upon outside agencies to reestablish the organization or to shape its policies.

Fidelity to these principles and the success which cooperative organizations may attain are primarily the responsibility of the producers. No organization will rise higher than the intelligence and loyalty of its members will carry it.

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Trend in Cooperative Development

Number of associations by kinds, and estimated number of members, 1915, 1925

Kind of association	1915		1925 [1]	
	Number	Members	Number	Members
Grain	1, 637	166, 828	3, 338	520, 000
Dairy products	1, 708	140, 567	2, 197	460, 000
Livestock	96	13, 438	1, 770	400, 000
Fruit and vegetable	871	109, 916	1, 237	180, 000
Cotton	213	18, 404	121	300, 000
Tobacco	43	17, 849	24	300, 000
All other	856	184, 184	2, 116	540, 000
Total	5, 424	651, 186	10, 803	2, 700, 000

[1] To Dec. 31, 1925.

Number of associations by geographic divisions and estimated amount of business, 1915, 1923

Geographic division	1915		1923 [1]	
	Number	Amount of business	Number	Amount of business
West North Central	2, 577	$286, 534, 775	4, 579	$635, 800, 000
East North Central	973	150, 510, 979	2, 620	413, 600, 000
Pacific	416	90, 113, 770	634	338, 800, 000
Middle Atlantic	210	56, 096, 060	531	275, 000, 000
West South Central	315	20, 485, 811	492	41, 800, 000
Mountain	232	10, 269, 102	387	145, 200, 000
South Atlantic	329	7, 683, 734	363	92, 400, 000
East South Central	215	7, 170, 323	298	189, 200, 000
New England	157	6, 974, 130	256	68, 200, 000
United States	5, 424	635, 838, 684	10, 160	2, 200, 000, 000

[1] To March, 1924.

Estimated amount of business by kinds of associations, 1915, 1923

Kind of association	1915		1923	
	Amount	Per cent	Amount	Per cent
Grain	$289,689,218	45.6	$600,000,000	27.3
Fruit and vegetable	201,542,646	31.7	300,000,000	13.6
Dairy products	89,061,370	14.0	400,000,000	18.2
Tobacco	6,450,000	1.0	150,000,000	6.8
Livestock	5,623,800	.9	[1] 250,000,000	11.4
Cotton	1,502,007	.2	100,000,000	4.5
Retailing	11,677,355	1.8	50,000,000	2.3
All others	30,292,288	4.8	350,000,000	15.9
Total	635,838,684	100.0	2,200,000,000	100.0

[1] Not including $200,000 of business by cooperative selling agencies in 19 terminal livestock markets.

Reasons for going out of business as given by 1,000 farmers' organizations no longer active[1]

Inefficient management	558
Lack of interest	556
Insufficient business	326
Insufficient working capital	282
Insufficient membership	222
Too liberal credit	187
Inadequate accounting system	114
Lack of proper audit	103
Dishonest management	100
Capital stock falling into hands of too few	32
Property damage by fire	12

[1] Some organizations gave more than one reason.

U. S. D. A.—10-1-26

AGRICULTURAL POPULATION

Farm Population

The farm population, as the term is here used, includes all persons actually living on farms, without regard to occupation, and also those farm laborers (and their families) who, although not living on a farm, nevertheless live in strictly rural territories, outside the limits of any village or other incorporated place.

Farm population and total population, by States, 1920 [1]

State	Total population	Farm population: Total: Number	Farm population: Total: Per cent of total population	Farm population: In cities and other incorporated places of 2,500 and over	Farm population: Total number in rural territory
Maine	768, 014	197, 601	25. 7	8, 575	189, 026
New Hampshire	443, 083	76. 021	17. 2	11, 414	64, 607
Vermont	352, 428	125, 263	35. 5	818	124, 445
Massachusetts	3, 852. 356	118. 554	3. 1	56, 822	61, 732
Rhode Island	604, 397	15, 136	2. 5	9, 821	5, 315
Connecticut	1, 380, 631	93, 302	6. 8	3, 005	90, 297
New York	10, 385. 227	800, 747	7. 7	17, 793	782, 954
New Jersey	3, 155, 900	143, 708	4. 6	6, 861	136. 847
Pennsylvania	8, 720, 017	948, 334	10. 9	6, 974	941, 360
Ohio	5, 759, 394	1, 139, 329	19. 8	5, 417	1, 133, 912
Indiana	2, 930, 390	907, 295	31. 0	4, 475	902, 820
Illinois	6. 485. 280	1, 098, 262	16. 9	7, 526	1, 090, 736
Michigan	3. 668. 412	848. 710	23. 1	4. 211	844, 499
Wisconsin	2, 632. 067	920, 037	35. 0	4, 800	915, 237
Minnesota	2, 387, 125	897, 181	37. 6	3, 721	893, 460
Iowa	2, 404, 021	984, 799	41. 0	7, 105	977, 694
Missouri	3, 404, 055	1, 211, 346	35. 6	3, 447	1, 207, 899
North Dakota	646, 872	394. 500	61. 0	878	393, 622
South Dakota	636. 547	362, 221	56. 9	335	361, 886
Nebraska	1, 296, 372	584, 172	45. 1	1, 434	582, 738
Kansas	1, 769. 257	737, 377	41. 7	1, 493	735. 884
Delaware	223, 003	51, 212	23. 0	61	51, 151
Maryland	1, 449, 661	279, 225	19. 3	1, 569	277, 656
District of Columbia	437, 571	894	.2	894	----------
Virginia	2. 309, 187	1, 064, 417	46. 1	4. 504	1, 059, 913

[1] From Vol. V, Fourteenth Census Reports.

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Farm population and total population, by States, 1920—Continued

State	Total population	Farm population			
		Total		In cities and other incorporated places of 2,500 and over	Total number in rural territory
		Number	Per cent of total population		
West Virginia	1,463,701	477,924	32.7	1,293	476,631
North Carolina	2,559,123	1,501,227	58.7	1,281	1,499,946
South Carolina	1,683,724	1,074,693	63.8	2,214	1,072,479
Georgia	2,895,832	1,685,213	58.2	4,602	1,680,611
Florida	968,470	281,893	29.1	2,523	279,370
Kentucky	2,416,630	1,304,862	54.0	2,520	1,302,342
Tennessee	2,337,885	1,271,708	54.4	2,529	1,269,179
Alabama	2,348,174	1,335,885	56.9	1,372	1,334,513
Mississippi	1,790,618	1,270,482	71.0	1,710	1,268,772
Arkansas	1,752,204	1,147,049	65.5	2,567	1,144,482
Louisiana	1,798,509	786,050	43.7	1,595	784,455
Oklahoma	2,028,283	1,017,327	50.2	1,428	1,015,899
Texas	4,663,228	2,277,773	48.8	12,039	2,265,734
Montana	548,889	225,667	41.1	278	225,389
Idaho	431,866	200,902	46.5	4,339	196,562
Wyoming	194,402	67,306	34.6	230	67,076
Colorado	939,629	266,073	28.3	792	265,281
New Mexico	360,350	161,446	44.8	904	160,542
Arizona	334,162	90,560	27.1	393	90,167
Utah	449,396	140,249	31.2	8,377	131,872
Nevada	77,407	16,164	20.9	61	16,103
Washington	1,356,621	283,382	20.9	3,360	280,022
Oregon	783,389	214,021	27.3	2,012	212,009
California	3,426,861	516,770	15.1	23,257	493,513
United States	105,710,620	31,614,269	29.9	255,629	31,358,640

Farm population of the United States, and total population, urban and rural, by sex, 1920 [1]

Class of population	Number			Males per 100 females
	Total	Male	Female	
Total population	105,710,620	53,900,431	51,810,189	104.0
Farm population	31,614,269	16,496,338	15,117,931	109.1
Per cent of total population	29.9	30.6	29.2	
Urban population	54,304,603	27,203,312	27,101,291	100.4
Rural population	51,406,017	26,697,119	24,708,898	108.0

[1] From Vol. V, Fourteenth Census Reports.

Farm population of the United States, and total population, by race, nativity, and parentage, 1920 [1]

Race, nativity, and parentage	Total population	Farm population	
		Number	Per cent of total population
All classes	105, 710, 620	31, 614, 269	29. 9
White	94, 820, 915	26, 313, 654	27. 8
Native	81, 108, 161	24, 842, 614	30. 6
Native parentage	58, 421, 957	21, 045, 836	36. 0
Foreign parentage	15, 694, 539	2, 326, 166	14. 8
Mixed parentage	6, 991, 665	1, 470, 612	21. 0
Foreign-born	13, 712, 754	1, 471, 040	10. 7
Colored (nonwhite)	10, 889, 705	5, 300, 615	48. 7
Negro	10, 463, 131	5, 112, 253	48. 9
Indian	244, 437	142, 714	58. 4
Chinese	61, 639	4, 287	7. 0
Japanese	111, 010	39, 504	35. 6
All other	9, 488	1, 857	19. 6

[1] From Vol. V, Fourteenth Census Reports.

Farm population of the United States, and total population, urban and rural, by age, 1920 [1]

Age group	Number			Per cent distribution		
	Total population	Farm population	Urban population	Total population	Farm population	Urban population
All ages	105, 710, 620	31, 614, 269	54, 304, 603	100. 0	100. 0	100. 0
Under 10 years	22, 971, 305	31, 138, 070	10, 326, 027	21. 7	25. 7	19. 0
10 to 20 years	21, 852, 795	7, 824, 106	10, 039, 484	20. 7	24. 7	18. 5
21 years and over	60, 886, 520	15, 652, 093	33, 939, 092	57. 6	49. 5	62. 5

[1] From Vol. V, Fourteenth Census Reports.

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Average expenditures for various groups of items as shown by value of material furnished by the farm and purchased in owners' and tenants' families

KENTUCKY, 1920 [1]

Item	Owner families (115)			Tenant families (93)		
	Furnished	Purchased	Total	Furnished	Purchased	Total
Food	$531.7	$308.4	$840.1	$481.5	$356.2	$837.7
Clothing	-------	284.1	284.1	-------	255.4	255.4
Rent	274.5	-------	274.5	163.3	.9	164.2
Furnishings	-------	19.0	19.0	-------	41.9	41.9
Operating	10.4	260.8	271.2	10.3	208.8	219.1
Health	-------	91.0	91.0	-------	86.8	86.8
Advancement	-------	155.7	155.7	-------	75.2	75.2
Personal	-------	13.5	13.5	-------	14.9	14.9
Savings	-------	47.2	47.2	-------	36.9	36.9
Unclassified	-------	7.0	7.0	-------	-------	-------
Total	816.6	1,186.7	2,003.3	655.1	1,077.0	1,732.1

TEXAS, 1920 [1]

Item	Owner families (102)			Tenant families (176)		
Food	$477.7	$272.5	$750.2	$367.0	$263.9	$630.9
Clothing	-------	381.8	381.8	-------	263.8	263.8
Rent	120.8	.8	121.6	81.2	3.9	85.1
Furnishings	-------	66.1	66.1	-------	23.7	23.7
Operating	7.3	229.2	236.5	7.6	145.3	152.9
Health	-------	68.8	68.8	-------	69.9	69.9
Advancement	-------	112.9	112.9	-------	37.2	37.2
Personal	-------	21.3	21.3	-------	21.3	21.3
Savings	-------	48.3	48.3	-------	40.7	40.7
Unclassified	-------	1.5	1.5	-------	6.4	6.4
Total	605.8	1,203.2	1,809.0	455.8	876.1	1,331.9

TENNESSEE, 1920–21 [1]

Item	Owner families (194)			Tenant families (52)		
Food	$339.7	$149.0	$488.7	$285.6	$150.0	$435.6
Clothing	-------	232.3	232.3	-------	173.9	173.9
Rent	165.5	.5	166.0	83.8	12.6	96.4
Furnishings	-------	24.7	24.7	-------	8.6	8.6
Operating	29.2	132.3	161.5	24.9	48.1	73.0
Health	-------	68.3	68.3	-------	18.7	18.7
Advancement	-------	124.4	124.4	-------	54.7	54.7
Personal	.4	16.5	16.9	.7	13.3	14.0
Savings	-------	41.5	41.5	-------	24.1	24.1
Unclassified	-------	.8	.8	-------	-------	-------
Total	534.8	790.3	1,325.1	395.0	504.0	899.0

[1] From unpublished data, Bureau of Agricultural Economics.

Average expenditures for various groups of items as shown by value of material furnished by the farm and purchased in owners' and tenants' families—Continued

LIVINGSTON COUNTY, N. Y., 1920–21 [2]

Item	Owner families			Tenant families		
	Furnished	Purchased	Total	Furnished	Purchased	Total
Food	$399	$379	$778	$398	$441	$839
Clothing	[3] 4	269	273	[3] 5	288	293
Rent	237	-------	237	226	-------	226
Fuel and light	56	90	146	69	72	141
Other operating	[4] 34	84	118	[4] 29	109	138
Health	-------	76	76	-------	102	102
Advancement	-------	318	318	-------	327	327
Personal	-------	23	23	-------	25	25
Incidentals	-------	14	14	-------	7	7
Total	730	1,253	1,983	727	1,371	2,098

MASON COUNTY, KY., YEAR ENDING JULY 1, 1923 [1]

Item	Owner families			Tenant families		
Food	$444.5	$177.0	$621.5	$390.5	$165.8	$556.3
Clothing	-------	263.0	263.0	-------	192.1	192.1
Rent	260.6	-------	260.6	140.4	-------	140.4
Furniture, etc	-------	34.0	34.0	-------	26.8	26.8
Operating	14.9	251.8	266.7	17.8	137.1	154.9
Health	-------	54.2	54.2	-------	44.8	44.8
Advancement	-------	120.4	120.4	-------	37.9	37.9
Personal	-------	38.7	38.7	-------	22.6	22.6
Savings	-------	136.8	136.8	-------	102.3	102.3
Unclassified	-------	7.6	7.6	-------	5.0	5.0
Total	720.0	1,083.5	1,803.5	548.7	734.4	1,283.1

[1] From unpublished data, Bureau of Agricultural Economics.
[2] Bulletin 423, Agricultural Experiment Station, Cornell University.
[3] Estimated value of clothing given by relatives and others.
[4] Labor furnished by members of the household estimated.

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REGULATORY WORK

Warehousing Farm Products Under the United States Warehouse Act

The United States warehouse act was passed in August, 1916. It has three primary purposes: (1) To encourage proper storage of agricultural products, (2) to eliminate unsound and loose warehousing practices and to encourage uniformity in warehousing methods, and (3) to develop a form of warehouse receipt generally acceptable as security for loans and thus make orderly marketing of agricultural products possible.

The law accomplishes its purposes through a system of licensing and bonding public warehousemen storing agricultural products. Federally licensed warehouses are not Government-owned institutions. Neither are they operated by the Government. They are owned and operated as private enterprises. They are inspected regularly and supervised carefully by the Government through the Department of Agriculture. This gives to warehouse receipts issued by Federally licensed warehouses a superior standing as collateral for loans.

The Federal warehouse act is not mandatory. Any operator of a public warehouse may apply for a Federal license. The requirements for licensing are:

(1) A suitable warehouse for the storage of the products.

(2) A competent person to operate the warehouse.

(3) The warehouseman must possess a certain amount of net assets.

(4) He must have a good business reputation.

(5) He must have such equipment as is necessary to care for the products.

(6) He must be able to weigh and to grade products carefully.

(7) He must furnish an acceptable bond in an amount fixed by the department.

An individual farmer's corncribs, granaries, and barns on farms are not licensable. Only public warehouses are eligible.

The number of Federally licensed warehouses is increasing rapidly. On May 1, 1924, the licensed storage capacity under this act was as follows:

Kind of warehouse	Number of warehouses	Aggregate storage capacity
Cotton	367	2,131,846 bales.
Grain	272	35,031,232 bushels.
Wool	10	25,801,500 pounds.
Tobacco	77	399,302,000 pounds.
Peanuts	1	3,385 tons.

When the warehouse act was first passed cotton, grain, wool, and tobacco were the only products to which it applied. On February 23, 1923, these limitations were removed. Since then the law has been extended to include peanuts, potatoes, and broomcorn. Further extensions will be made as rapidly as possible.

The warehouse act is administered in such a way as to obtain the most benefit for the farmer. The popularity of the act is attested by the fact that many cotton, grain, tobacco, and other cooperative associations are using it.

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3. AGRICULTURAL ENGINEERING [1]

- .0 General engineering.
  - .00 General.
    - .001 Mathematics.
    - .002 Tables.
    - .009 Miscellaneous.
  - .01 Applied mechanics.
  - .02 Hydraulics. (See .21.)
  - .03 Thermodynamics.
  - .04 Civil, structural, and architectural engineering.
    - .040 General.
    - .041 Design.
      - .0410 General.
      - .0411 Foundations.
      - .0412 Piers and columns.
      - .0413 Beams and girders.
      - .0414 Trusses and arches.
      - .0415 Retaining walls, dams, and sea walls.
      - .0416 Fastenings.
      - .0419 Miscellaneous.
    - .042 Surveying and drawing.
    - .049 Miscellaneous.
  - .05 Electrical engineering.
  - .06 Mechanical engineering.
  - .07 Trades and shop practice.
    - .071 Welding and babbitting.
    - .072 Forge and metal work.
    - .079 Miscellaneous.
  - .08 Standards, commercial sizes, and practices.
  - .09 Miscellaneous.
- .1 Materials (manufacture, tests, strength, preservation).
  - .10 General (corrosion, etc.).
  - .11 Animal (leather, etc.).
  - .12 Vegetable (material sense only—rubber, wood, etc.).
  - .13 Mineral (abrasives, asbestos, metals, natural stones, etc.).
  - .14 Chemicals and explosives.
  - .15 Ceramics (bricks, glass, tile, etc.).
  - .16 Cement (concrete, gravel, plaster, sand, etc.).
    - .160 General.
    - .161 Effect of alkali and acids on concrete. (See .2341.)
    - .169 Miscellaneous.
  - .17 Oils, petroleum compounds, paints (asphalts, tars, whitewash, etc.).
  - .18 Compositions and textiles.
  - .19 Miscellaneous (adhesives, etc.).
- .2 Land development.
  - .20 General.
  - .21 Hydraulics of irrigation and drainage.
    - .210 General.
    - .211 Run-off.
    - .212 Flow and conveyance of water.
      - .2120 General.
      - .2121 Flow in open channels.
      - .2122 Flow through tile, flumes, and pipe.
      - .2123 Flow through culverts.
      - .2124 Flow around bends and piers.
      - .2129 Miscellaneous.

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[1] This classification key has been officially adopted by the American Society of Agricultural Engineers.

8.

.2 Land development—Continued.

.21 Hydraulics of irrigation and drainage—Continued.

.213 Measurement of water.

.214 Storage of water.

.215 Losses of water.

.2150 General.

.2151 Seepage and percolation.

.2152 Evaporation.

.2159 Miscellaneous.

.219 Miscellaneous.

.22 Drainage and flood control.

.220 General.

.2201 Reports on drainage projects.

.2202 Publications on drainage.

.2203 Statistics.

.221 Structures.

.2210 General.

.2211 Open channels.

.22111 Ditching with dynamite.

.2212 Tile drains.

.22120 General.

.22121 Catch basins, manholes.

.22122 Bulkheads.

.22129 Miscellaneous.

.2213 Levees.

.2214 Drainage pumping plants. (See .2318 and .351.)

.2215 Vertical drains.

.2216 Sedimentation basins.

.2219 Miscellaneous.

.222 Drainage district administration. (See .261.)

.2220 General.

.2221 Laws.

.2222 Contracts and specifications.

.2229 Miscellaneous.

.223 Effects of drainage.

.2230 General.

.2231 Subsidence of peat and muck soils.

.2232 Ground-water investigations.

.2233 Economics.

.2239 Miscellaneous.

.224 Erosion.

.2240 General.

.2241 Terracing.

.2242 Control of gullies.

.2249 Miscellaneous.

.229 Miscellaneous.

.23 Irrigation.

.230 General.

.2301 Reports on irrigation projects.

.2302 Publications on irrigation.

.2303 Statistics.

.231 Structures.

.2310 General.

.2311 Canals and ditches.

.23110 General.

.23111 Canal lining.

.23112 Maintenance.

.23119 Miscellaneous.

.2312 Dams.

.2313 Spillways.

.2314 Gates.

.2315 Chutes and drops.

.2316 Pipes, flumes, siphons, tunnels.

.2317 Farm ditch structures.

.2318 Pumping plants. (See .2214 and .35.)

.2319 Miscellaneous.

.2 Land development—Continued.
.23 Irrigation—Continued.
.232 Farm practice in applying water.
.2320 General.
.2321 Preparation of land.
.2322 Water requirements of crops.
.2323 Methods of irrigating specified crops.
.2324 Surface irrigation.
.2325 Spray irrigation.
.2326 Subirrigation.
.2329 Miscellaneous.
.233 Sewage irrigation.
.234 Effects of irrigation.
.2340 General.
.2341 Water-logging and alkali. (See .225.)
.2342 Economics.
.2349 Miscellaneous.
.235 Soil-moisture investigations.
.236 Irrigation organization administration.
.2360 General.
.2361 Federal and State.
.2362 Irrigation districts. (See .262.)
.2363 Mutual water companies.
.2364 Other forms of organization.
.2365 Laws.
.2366 Contracts and specifications.
.2369 Miscellaneous.
.239 Miscellaneous.
.24 Land clearing.
.240 General.
.241 Removal of trees and stumps.
.2410 General.
.2411 With mechanical equipment. (See .366.)
.2412 With explosives.
.2413 By burning.
.2414 By poisoning.
.2419 Miscellaneous.
.242 Removal of brush.
.2420 General.
.2421 Mechanical means. (See .366.)
.2422 With animals.
.2423 By chemical treatment.
.2429 Miscellaneous.
.243 Removal of bowlders.
.244 Distillation of stumps.
.249 Miscellaneous.
.25 Reforestation.
.26 Land settlement (colonization).
.260 General.
.261 Drainage districts. (See .222.)
.262 Irrigation districts. (See .2362.)
.263 Cut-over lands.
.269 Miscellaneous.
.29 Miscellaneous.
.3 Machinery and equipment.
.30 General.
.301 History.
.302 Statistics.
.303 Relation of machinery to production.
.304 Economics.
.3040 General.
.3041 Cost.
.3042 Depreciation.
.3049 Miscellaneous.
.305 Machine design.
.306 Traction to dynamometer tests.
.307 Lubrication.
.309 Miscellaneous.

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.3 **Machinery and equipment—Continued.**
.31 Crop machinery.
.310 General.
.3101 Statistics.
.3102 Duty.
.3103 Power requirements.
.3104 Manufacturers and catalogues.
.3109 Miscellaneous.
.311 Tillage machinery.
.3110 General.
.31101 Relation of soil dynamics to tillage.
.3111 Plows and ridging devices.
.3112 Subsoilers.
.3113 Harrows and rollers.
.3114 Drags, floats, and smoothers.
.3115 Cultivators and weeders.
.3119 Miscellaneous.
.312 Seeding machinery.
.3120 General.
.3121 Grain seeders and drills.
.3122 Grass seeders and drills.
.3123 Corn and cotton planters.
.3124 Potato planters.
.3125 Beet planters.
.3126 Garden seeders.
.3127 Transplanters.
.3128 Row markers.
.3129 Miscellaneous.
.313 Harvesting machinery.
.3130 General.
.3131 Grain binders, headers, reapers and combines, shocker and shock loaders.
.3132 Corn, cane, and bean harvesters.
.3133 Cotton pickers.
.3134 Root-crop diggers and harvesters.
.3135 Mowers, rakes, loaders, and stackers.
.3136 Fruit and nut gathering equipment.
.3137 Vegetable machinery.
.3139 Miscellaneous.
314. Crop-processing machinery.
.3140 General.
.3141 Threshers and hullers.
.3142 Graders and cleaners.
.3143 Shellers, shredders, and cutters.
.3144 Balers, presses, hay-curing equipment.
.3145 Cotton-ginning machinery.
.3146 Cane and juice mills.
.3147 Dryers and dehydraters.
.3149 Miscellaneous.
.315 Spraying, dusting, and fumigating machinery.
.3150 General.
.3151 Spraying.
.3152 Dusting.
.3153 Fumigating.
.3154 Sterilizing.
.3159 Miscellaneous.
.316 Fertilizing machinery.
.3160 General.
.3161 Manure spreaders.
.3162 Straw spreaders.
.3163 Fertilizer distributors.
.3164 Lime spreaders.
.3169 Miscellaneous.

.3 Machinery and equipment—Continued.
.31 Crop machinery—Continued.
.317 Crop loading, elevating, and conveying machinery.
.3170 General.
.3171 Hay forks and equipment.
.3172 Grain elevators and conveyor.
.3179 Miscellaneous.
.319 Miscellaneous.
.32 Livestock and dairy machinery.
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AGRICULTURAL ENGINEERING

TABLES

Equivalents

Long measure

Inches	Feet	Yards	Rods [1]	Furlongs	Miles
12	1				
36	3	1			
198	16½	5½	1		
7, 920	660	220	40	1	
63, 360	5, 280	1, 760	320	8	1

[1] Rod or perch or pole.

7.92 inches=1 link; 1 palm=3 inches.
1 chain=100 links; 1 hand=4 inches.
1 chain=66 feet; 1 span=9 inches.
1 chain=4 rods; 1 point=$\frac{1}{72}$ inch.
80 chains=1 mile; 1 inch=1,000 mils.
1 inch=2.54 centimeters; 1 foot=0.3048 meter; 1 yard=0.9144018 meter.
1 meter=39.37 inches; 1 kilometer=1,093.61 yards=0.62137 mile.

Square measure

Inches	Feet	Yards	Rods [1]	Roods	Acres	Miles
144	1					
1, 296	9	1				
	272¼	30¼	1			
	10, 890	1, 210	40	1		
	43, 560	4, 840	160	4	1	
				2, 560	640	1

[1] Perch or square rods.

1 square (builders')=100 square feet.
1 section of land=1 mile square.
¼ section of land=160 acres.
1 acre=208.71 feet square.
1 square inch=6.452 square centimeters. 1 square foot=0.0929 square meter. 1 square yard=0.836 square meter.
1 square millimeter=0.00155 square inch=1,973.5 circular mils.
1 square meter=10.764 square feet=1.196 square yards.
1 hectare=107,638.7 square feet=2.471 acres.

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Cubic measure

1,728 cubic inches = 1 cubic foot.
27 cubic feet = 1 cubic yard.
1 liquid gallon = 231 cubic inches.
1 dry gallon = 268.8 cubic inches.
1 cubic foot = 7.48 liquid gallons.
1 cubic foot = 6.428 dry gallons.
1 perch = 16½ cubic feet (24¾ and 22 used sometimes).

1 foot B. M. = 144 cubic inches. 1 cord = 4 by 4 by 8 feet = 128 cubic feet.

1 cubic inch = 16.387 cubic centimeters. 1 cubic foot = 28.32 liters. 1 cubic yard = 0.7645 cubic meter.

1 gallon = 3.785 liters. 1 bushel = 35.2383 liters.

1 cubic meter = 35.314 cubic feet = 1.308 cubic yards = 61023.38 cubic inches.

1 liter = 1 cubic decimeter = 61.025 cubic inches = 0.035314 cubic foot = 1.0567 quarts = 0.264 gallon = 0.028378 bushel.

Liquid measure

Minims	Drams	Ounces	Gills	Pints	Quarts	Gallons
1						
60	1					
480	8	1				
1, 920	32	4	1			
7, 680	128	16	4	1		
15, 360	256	32	8	2	1	
61, 440	1, 024	128	32	8	4	1

1 firkin = 9 gallons. 1 barrel = 31½ gallons.

Dry measure

Pints	Quarts	Gallons	Pecks	Bushels
2	1			
8	4	1		
16	8	2	1	
64	32	4	4	1

1 struck bushel = 2,150.42 cubic inches.
1 heaped bushel = 2,747.715 cubic inches.
1 dry barrel = 7,056 cubic inches = 105 quarts.
1 lime barrel = 3½ bushels or 280 pounds.

Troy weight

Grains [1]	Penny-weight	Ounces	Pounds
24	1		
480	20	1	
5, 760	240	12	1

[1] The grain is the same in troy, avoirdupois, and apothecaries' weights. 1 pound troy = 0.82286 pound avoirdupois.

Apothecaries' weight

Grains[1]	Scruples	Drams	Ounces	Pounds
20	1	----------	----------	----------
60	3	1	----------	----------
480	24	8	1	----------
5, 760	288	96	12	1

Avoirdupois weight

Grains[1]	Drams	Ounces	Pounds	Hundred-weight	Tons
27. 343	1	----------	----------	----------	----------
437. 5	16	1	----------	----------	----------
7, 000	256	16	1	----------	----------
----------	----------	1, 600	100	1	----------
----------	----------	32, 000	2, 000	20	1

1 long ton=2,240 pounds.
1 stone=14 pounds.

[1] The grain is the same in troy, avoirdupois, and apothecaries' weights. 1 pound troy=0.82286 pound avoirdupois.

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MATERIALS

Metals

Wire and sheet metal gauges in approximate decimals of an inch

Number of wire gauge	American or Brown & Sharpe	Birmingham or Stub's iron wire	Washburn & Moen,[1] American Steel & Wire Co., and Roebling	Stub's steel wire	Trenton Iron Co.	British[1] Imperial wire	United States standard for plate
0	0.3249	0.340	0.3065	--------	0.3050	0.3240	0.3125
1	.2893	.300	.2830	0.227	.2850	.3000	.2813
2	.2576	.284	.2625	.219	.2650	.2760	.2656
3	.2294	.259	.2437	.212	.2450	.2520	.2500
4	.2043	.238	.2253	.207	.2250	.2320	.2344
5	.1819	.220	.2070	.204	.2050	.2120	.2188
6	.1620	.203	.1920	.201	.1900	.1920	.2031
7	.1443	.180	.1770	.199	.1750	.1760	.1875
8	.1285	.165	.1620	.197	.1600	.1600	.1719
9	.1144	.148	.1483	.194	.1450	.1440	.1563
10	.1019	.134	.1350	.191	.1300	.1280	.1406
11	.0907	.120	.1205	.188	.1175	.1160	.1250
12	.0808	.109	.1055	.185	.1050	.1040	.1094
13	.0720	.095	.0915	.182	.0925	.0920	.0938
14	.0641	.083	.0800	.180	.0800	.0800	.0781
15	.0571	.072	.0720	.178	.0700	.0720	.0703
16	.0508	.065	.0625	.175	.0610	.0640	.0625
17	.0453	.058	.0540	.172	.0525	.0560	.0563
18	.0403	.049	.0475	.168	.0450	.0480	.0500
19	.0359	.042	.0410	.164	.0400	.0400	.0438
20	.0320	.035	.0348	.161	.0350	.0360	.0375
21	.0285	.032	.0317	.157	.0310	.0320	.0344
22	.0253	.028	.0286	.155	.0280	.0280	.0313
23	.0226	.025	.0258	.153	.0250	.0240	.0281
24	.0201	.022	.0230	.151	.0225	.0220	.0250
25	.0179	.020	.0204	.148	.0200	.0200	.0219
26	.0159	.018	.0181	.146	.0180	.0180	.0188
27	.0142	.016	.0173	.143	.0170	.0164	.0172
28	.0126	.014	.0162	.139	.0160	.0148	.0156
29	.0113	.013	.0150	.134	.0150	.0136	.0141
30	.0100	.012	.0140	.127	.0140	.0124	.0125

[1] Sizes range from No. 7/0 to No. 50; other gauges not so extensive.

In order to avoid confusion it is best to designate the size of wire in decimals of an inch and not to refer to the gauge numbers.

The Birmingham is the only wire gauge that has been recognized in acts of Congress. The Treasury Department uses this gauge in connection with importations of wire, and the adoption of succeeding tariff acts with provisions for assessment of duty according to gauge numbers gives legislative sanction to the gauge. The gauge is defective and nearly obsolete.

The principal wire manufacturers use Washburn & Moen gauge, which is the same as the American Steel & Wire Co.'s, also Roebling's gauge. This gauge applies to all steel wire. The Bureau of Standards has recom-

mended that this gauge be designated as the "steel wire gauge."

The "American Steel & Wire Co.'s music wire gauge" is adopted as the standard for piano wire upon the recommendation of the Bureau of Standards.

The "American wire gauge," which is known as the "Brown & Sharpe gauge," is universally recognized in the United States as the standard for copper wires and wires of other metals.

The United States standard gauge for sheet and plate iron and steel wires was legalized by act of Congress, March 3, 1893, as a standard gauge to be used by the Customs Division of the Treasury Department for sheet iron and steel. This gauge is also used by about 45 sheet and tin-plate manufacturers.

Waterproofing and Mildewproofing of Canvas

The fabric should be of good quality, tightly woven, and practically free from pinholes. A low-grade cloth is difficult to waterproof and is not durable. The following formulas devised by the Bureau of Chemistry are satisfactory for increasing the serviceability of cotton duck:

Dark or yellow petrolatum (vaseline).	8½ pounds.
Beeswax	1½ pounds.
Gasoline	3 gallons.
Kerosene	2 gallons.
Mineral pigment (ground in linseed oil).	1 pound to each gallon of prepared solution.

Asphalt (petroleum or Bermudez).	7½ pounds.
Dark or yellow petrolatum (vaseline).	2½ pounds.
Gasoline	3 gallons.
Kerosene	2 gallons.
Mineral pigment (ground in linseed oil).	1 pound to each gallon of prepared solution.

Mineral pigments protect the canvas from deterioration by sunlight. For a buff or khaki-colored pigment use yellow ochre; for a darker buff or light brown use raw sienna; for dark red or reddish brown use burnt sienna; for olive brown use raw umber; for a dark brown use burnt umber; and for white use zinc oxide.

Weigh the solid materials in proper proportions, place (except the pigment) in a kettle or can and melt carefully at as low a temperature as possible, with constant stirring. When the material has melted remove it to a safe distance from the fire and pour it slowly, while stirring, into the solvent. Then add 1 pound of the pigment to every gallon of the prepared solution. The mixture containing beeswax should be warmed just before it is applied to the canvas. Place the open container in a tub or can of hot water. Never place it over or near a flame. Stir thoroughly before and during application to keep the undissolved material in suspension. Apply by means of a paintbrush or by spraying. One coat on one side of the canvas is usually sufficient. The quantities given are sufficient for treating about 40 square yards of canvas with one coat on one side.

For fixed canvas, such as permanent wagon covers, boiled linseed oil containing a pigment can be used. This stiffens the canvas and is not suitable for covers that are frequently folded. Lampblack (one-half pound per gallon), aluminum bronzing powder, and zinc oxide (1 pound per gallon) are good protective pigments for use with boiled linseed oil.

LAND DEVELOPMENT

Soil-Moisture Determinations

Augers of the posthole type, the carpenter's bit with the shank extended, or soil tubes are most commonly used for taking soil samples. Samples should be taken in 1-foot sections, 1 or 2 inches in diameter, and the entire sample retained for moisture determination. Soil should be placed in air-tight containers, either screw-top fruit jars or cans with tight-fitting covers, as soon as sample is taken. If a stratum of a different soil type 2 or more inches thick is encountered it should be sampled separately. Sufficient samples should be taken to give representative results. Samples should be dried at temperatures ranging from 100° to 110° C. From 24 to 72 hours time is necessary to dry the samples. The amount of moisture should be expressed as a percentage of the dry weight of the soil.

Drainage and Flood Control

Tile Drains.—Water enters a tile through the joints and not through the walls of the tile as many suppose. As there is a joint every foot, the water comes in along the tile line in very small quantities with no perceptible current, so that under normal conditions no mud or sand will enter the tile that will not pass out with the water if the tile is properly laid. The following rules for tile drainage should be observed:

(1) Use dense, hard-burned tile. Round tile is best.

(2) Do not use tile smaller than 4 inches in diameter.

(3) Time and labor will be saved by use of the proper tools.

(4) An even grade is essential. Sags or "humps" in the line must be avoided.

(5) The bottom of the trench should be rounded to fit the tile.

(6) Lay the tile as close together as it is possible to fit them. Cover all cracks of more than one-eighth inch with pieces of broken tile.

(7) The tile should at all times be laid as far as the trench bottom has been prepared. If a trench is allowed to stand open for a considerable length of time, the bottom is liable to become soft and the sides may cave in.

(8) At the close of each day's work the upper end of the tile line should be closed by the placing of a board or flat stone securely against the end tile to prevent entrance of dirt; the line should be "blinded" by careful covering of the tile with 4 to 6 inches of dirt and care taken that none of the tile is displaced during the operation.

(9) Carefully construct and protect the outlet.

(10) Make a permanent record of the location of each tile line so that it can be found again in an emergency.

Tools required for laying tile drains by hand, after line has been located and staked out, are as follows:

(1) Grade bars.
(2) Grade cord.
(3) Tiling spades.
(4) Round-nosed, long-handled shovels.
(5) Tiling scoop for shaping bottom of trench.
(6) Carpenter's level for use in leveling cross arms.

Depth and spacing.—The spacing and depth of tile drains will depend upon the closeness of the soils; namely, upon its retentive properties. Soils are usually spoken of as "open" or "close" with respect to their drainage properties. In general, close soils which consist

largely of clay or alluvial gumbo should have drains spaced from 40 to 80 feet apart and placed from 2½ to 3½ feet deep. In open soils, such as sandy loam or gravel, the drains should be from 100 to 200 feet apart and from 4 to 4½ feet deep. In general, tile lines spaced from 60 to 80 feet apart and laid at a depth of 3 feet give satisfactory results in the average soils needing a complete system of tile drainage. It is not advisable to lay tile less than 2½ feet deep unless the topography of the ground or the presence of rock or an impervious subsoil makes it necessary.

Acres drained by tile mains laid upon grades indicated

[Fall per 100 feet in decimals of a foot, with approximate equivalent in inches]

Diameter of tile, inches	Fall												
	0.04 foot (½ inch)	0.05 foot (⅝ inch)	0.08 foot (1 inch)	0.10 foot ($1\frac{3}{16}$ inches)	0.12 foot (1½ inches)	0.16 foot (2 inches)	0.20 foot (2⅜ inches)	0.25 foot (3 inches)	0.30 foot (3⅝ inches)	0.40 foot (4¾ inches)	0.50 foot (6 inches)	0.75 foot (9 inches)	1 foot (12 inches)
4	----	----	----	----	----	----	10	12	13	14	15	19	23
5	----	----	12	13	14	15	17	20	22	25	28	34	40
6	13	14	18	20	22	25	28	32	35	40	46	56	65
8	27	30	38	42	47	56	61	69	76	88	100	120	140
10	50	55	70	79	86	100	114	124	135	155	176	215	250
12	80	90	118	125	140	160	180	200	225	255	285	345	410

Limit of size of tile to grade and length

Size of tile	Minimum fall per 100 feet	Limit of length	Size of tile	Minimum fall per 100 feet	Limit of length
Inches	*Feet*	*Feet*	*Inches*	*Feet*	*Feet*
4	0.10	2,000	8	0.05	4,000
5	.10	2,500	10	.04	5,000
6	.06	3,000	12	.04	6,000

Quantity of tile required per acre for laterals for different spacing of laterals

Distance between laterals	Quantity of tile required	Distance between laterals	Quantity of tile required
Feet	*Feet*	*Feet*	*Feet*
30	1,457	90	484
40	1,089	100	436
50	872	110	396
60	726	120	364
70	623	150	291
80	545		

Average weight of drain tile and average number of feet in carload

Size of tile	Weight per foot	Content of average carload	Size of tile	Weight per foot	Content of average carload
Inches	*Pounds*	*Feet*	*Inches*	*Pounds*	*Feet*
4	6	6,000	8	18	2,400
5	8	5,000	10	25	1,600
6	11	4,000	12	33	1,000
7	14	3,000			

Soil Erosion

Terraces.—One of the most satisfactory types of terrace is the broad-base, variable-graded ridge terrace generally known as the Mangum terrace. This terrace should be built from 10 to 20 feet broad at the base and with the top of the terrace about 15 inches higher than the bottom of the channel above the terrace. The following general rules for constructing terraces should be used:

(1) Short terraces are less likely to break than long ones and are therefore more desirable. Under ordinary conditions terraces should be laid off so as not to exceed a length of 1,000 feet from the highest point in the terrace to the outlet.

(2) The fall of a terrace should vary from one-half inch per 100 feet at the upper end to not exceeding 6 inches per 100 feet at the lower end, the maximum fall depending upon the length of the terrace and the character of the soil.

(3) Begin laying off a system of terraces near the middle of the upper terrace. Obtain the starting point of the upper terrace by measuring down the proper vertical distance from the top of the hill or field.

(4) If the field to be terraced does not extend to the top of the hill a hillside ditch should be dug along the upper side of the field to intercept the water draining from the area above.

(5) In crossing gullies or draws the terrace should be built higher and stronger than at other points to prevent washing out.

(6) When the terrace crosses a draw, the grade leading into it should never be greater and should preferably

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be less than the grade leading out, because a greater grade would result in more water being brought into the draw than would be carried out on the smaller grade.

(7) Protect the outlets of the terraces so that erosion does not occur, usually by seeding to grass or by building dams of brush, rock, or concrete across the ditch at suitable intervals.

Vertical distance between terraces

Slope of land per 100 feet	Vertical distance, or drop between terraces
Feet	*Feet*
0 to 5	3
5 to 10	4
10 to 15	5

Fall in inches per 100 feet for use with variable graded terraces

Length	Slope of land		
	5-foot fall in 100 feet	10-foot fall in 100 feet	15-foot fall in 100 feet
Feet	*Inches*	*Inches*	*Inches*
0 to 300	½	¾	1
300 to 600	1	1½	2
600 to 900	2	3	4
900 to 1,100	4	6	6

Soil-Saving Dams.—Before beginning work decide upon a plan for the reclamation of the entire gully. Attention should first be directed to the upper end where head erosion is going on. Stop this by building an overfall of brush and straw. Unless conditions make it necessary to use high dams, low ones should be used, since the cost will be less, and low dams are much less subject to failure.

Diameter of pipe for outlets through soil-saving dams for different-sized drainage areas

Diameter of pipe	Area drained	Diameter of pipe	Area drained
Inches	*Acres*	*Inches*	*Acres*
12	5	24	20
15	8	27	26
18	11	30	33
21	15	36	50

Irrigation

Location of Ditch.—(1) Aim to locate and design the supply ditch so as to convey water with the least possible loss to the highest part of the farm. (2) Where possible run parallel to fence lines or field borders. (3) Aim to employ grades which will give approximately the following maximum velocities: In fine sand or sediment, 1 foot per second; in hard gravel or clay, 3 feet per second; in material ranging from sandy or gravelly loam to clay loam, 2 to 2½ feet per second. (4) On rolling land or steep slopes try to run ditches across rather than down slopes. When necessary to run ditches down slopes, check the velocity at intervals by the use of drops. (5) Design ditches so that surface of water will be higher than the land surface.

Construction.—Plow the ground to the width to be covered by ditch and banks. With small ditches run lister or ditch plow through once and shape ditch by hand or with small log crowder. With next larger size ditches, plow as many furrows as needed, using V crowder to shape ditch and piling earth in banks; or use wing plow to plow and clean ditch at the same time. For still larger ditches use blade machine with ample range of adjustment of blade; or use scrapers. If necessary to build ditch in filled land over low places plow the ground beneath it and make a compact fill with earth from adjoining ground. Then shape the ditch on top as on level ground. Build ditches some time in advance of use to give banks time to settle.

Capacities.—If water is to be delivered in continuous stream for general field crops ditches should carry 2 feet per second. If water is delivered for short periods capacities should be three-fifths to 1 second-foot for citrus groves, 1 to 3 second-feet for diversified crops. For alfalfa or meadows or for irrigation during rainy seasons of Pacific coast, capacities should be 6 to 10 second-feet or larger.

Pumps for Irrigation.—The farmer should engage the services of a reliable well driller and see that a well-drilling contract is drawn up which will protect him against unwarranted expense or inferior work.

The well casing should be of a standard type, such as screw, riveted, or stovepipe casing, and the portion in contact with water-bearing formations should be perforated so as to admit water in sufficient quantities and to screen out the sand and gravel.

Before pumping equipment is purchased the well should be thoroughly tested to determine its capacity and draw-down.

In general, the type of pump to install in a well is determined by the height through which the water must be raised, as follows:

Type of pump for lift	Feet
Horizontal centrifugal	0 to 50.
Horizontal centrifugal or turbine	50 to 75.
Turbine	75 to 150.
Turbine or plunger	150 to 250.
Turbine	More than 250.

If quantity to be pumped is small, the plunger pump is best for lifts above 75 feet.

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Typical capacities of centrifugal pumps and horsepower required for their operation under average conditions[1]

Number	Discharge per minute	Theoretical horsepower per foot of lift	Efficiency[1]	Actual horsepower[2] per foot of lift
	U. S. gallons		*Per cent*	
2	100	0.025	40 to 45	0.06
2½	150	.038	45 to 50	.08
3	225	.056	50 to 55	.11
3½	300	.075	55 to 60	.14
4	400	.100	60 to 62	.17
5	700	.175	62 to 66	.28
6	900	.225	66 to 68	.34
7	1,200	.300	68 to 70	.44
8	1,600	.400	70 to 74	.57

[1] Efficiencies are for pumps properly designed and installed for heads of 40 to 60 feet. Plant efficiencies can be estimated by subtracting 10 per cent for direct-connected electric motors and 17 to 22 per cent for belt-connected power.

[2] Efficiencies taken as the lower figure in preceding column.

Preparation of Land.—(1) The "cut" should approximately equal the "fill." (2) Make due allowance for shrinkage or settling of the fill. If fill is more than a few inches deep it should be irrigated before being seeded. (3) Avoid depressions with outlets. Do not block or unduly obstruct natural watercourses. (4) Avoid exposing unproductive or refractory subsoil by the removal of too much topsoil. (5) Remember that the object of grading is that water may be spread uniformly with the minimum of labor and expense.

Procedure.—(1) Divide tract into rectangles and determine elevations of corners and other points where there are abrupt changes of surface. (2) Plot to scale the locations of the points so determined and draw lines (called contours) through points of equal elevation. Draw a contour for each foot or half foot throughout the range of elevations, and label each with its elevation. Ink in these lines. (3) Draw in the contours of the surfaces to which it is proposed to reduce the surface. These will be straight lines equally spaced on the drawing. (4) Where the natural contours intersect the proposed graded-surface contours note the difference in elevation, marking the point plus (+) if the natural surface is the higher and minus (−) if lower. (5) Draw a third series of lines joining points of equal cut and joining points of equal fill and ink them in, using a different color of ink from that used for the contours. The result will show to the eye the amount of cut and fill required, how far the earth must be moved, and whether the cut will approximately equal the fill.

Irrigation of Special Crops

Seasonal quantity of delivered water and the number of irrigations required for specified crops

Crop	Mean low requirement in acre-feet per acre	Mean high requirement in acre-feet per acre	Number of irrigations	
			From—	To—
Alfalfa	2.5	3.5	3	[illegible]
Clover	2.5	3.0	3	4
Cereals	1.2	2.0	1	3
Corn	0.9	1.3	1	3
Sugar beets	1.5	2.5	3	6
Potatoes	1.1	2.0	2	4
Orchards	1.5	2.3	3	5
Cotton	1.5	2.5	2	3
Sugar cane	5.0	10.0	10	20
Rice	4.5	6.0	Submerged during part of growth	

Power Requirements

Work factors for farm operations

Operation or implement	Power unit, number of horses	10-hour duty per foot of width	Range of reported widths	Most usual width per horse
		Acres		*Feet*
Walking plow	2	1.7	8 to 14 inches	0.50
Do	3	2.1	10 to 16 inches	.44
Sulky plow	2	1.7	do	.58
Do	3	2.2	12 to 16 inches	.44
Gang plow	4	2.2	18 to 28 inches	.58
Do	5	2.3	24 to 28 inches	.47
Do	6	2.3	24 to 32 inches	.39
Spike-tooth harrow:				
On fresh plowing On well-packed land	2	1.5 1.7	6 to 12 feet	4.00
On fresh plowing On well-packed land	3	1.6 1.9	8 to 16 feet	3.50
On fresh plowing On well-packed land	4	1.8 2.1	10 to 26 feet	4.25
Spring-tooth harrow:				
On fresh plowing On well-packed land	2	1.2 1.5	4 to 8 feet	3.00
On fresh plowing On well-packed land	3	1.4 1.7	5 to 10 feet	2.33
On fresh plowing Onwell-packed land	4	1.6 1.8	6 to 12 feet	2.00

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Work factors for farm operations—Continued

Operation or implement	Power unit, number of horses	10-hour duty per foot of width	Range of reported widths	Most usual width per horse
Disk harrow:		*Acres*		*Feet*
On fresh plowing	2	1.1	4 to 8 feet	3.00
On well-packed land		1.2		
On fresh plowing	3	1.2	6 to 10 feet	2.25
On well-packed land		1.6		
On fresh plowing	4	1.7	do	2.00
On well-packed land		2.0		
Land roller	2	1.7	5 to 12 feet	4.00
Do	3	1.7	do	2.00
Do	4	1.8	8 to 16 feet	2.50
Grain drill	2	1.46	4 to 8 feet	3.25
Do	3	1.56	6 to 10 feet	2.50
Do	4	1.82	6 to 12 feet	2.25
Do	6	1.98	8 to 12 feet	1.75
Corn or cotton planter:				
1-row	1	2.28	36 to 48 inch rows.	3.00
Do	2	3.10	do	1.50
2-row	2	1.9	do	3.50
Covering seed potatoes	1	2.10	24 to 32 inch rows.	2.00
Do	2	2.62	do	2.33
Potato planter	2	2.20	do	2.33
Lime spreader	2	1.15	6 to 12 feet	4.00
Fertilizer drill	2	1.36	5 to 10 feet	3.00
Do	3	1.46	6 to 12 feet	2.66
Field sprayer	1	1.15	3 to 4 rows	11.00
Do	2	1.30	do	6.00
Mowing hay	2	1.68	4 to 7 feet	2.50
Raking hay	1	1.78	6 to 12 feet	9.00
Do	2	1.90	8 to 16 feet	6.00
Tedding hay	1	1.69	6 to 8 feet	7.00
Do	2	2.06	6 to 10 feet	4.25
Grain binder	3	1.79	4 to 7 feet	2.00
Do	4	2.08	5 to 8 feet	2.00
Do	5	2.18	do	1.66
Grain header	4	2.03	10 to 12 feet	3.00
Do	5	2.13	do	2.25
Do	6	2.23	12 to 14 feet	2.33
Corn binder	3	2.09	36 to 48 inch rows.	1.50
Cultivating	1	1.5		
Do	2	2.0		
Hand corn planter		1.34	36 to 48 inch rows.	

Approximate power required for farm operations

FIELD OPERATIONS

Operation	Soil	Draft pounds per foot in width covered	Horse-power-hours per acre
Plowing 6 inches deep	Sandy loam	200 to 400	4.5 to 9.
Do	Sandy clay loam	350 to 500	8 to 11.
Do	Clay loam	400 to 600	9 to 13.
Do	Heavy clay	600 to 1,000	13 to 22.
Do	Gumbo	1,000 to 1,500	22 to 33.
Peg-tooth harrow	Average	15 to 60	0.3 to 1.3.
Spring-tooth harrow	do	25 to 70	0.5 to 1.5.
Disk harrow (single)	Clay loam	70 to 100	1.5 to 2.2.
Do	Heavy clay	100 to 150	2.2 to 3.3.
Land roller	Average	20 to 80	0.4 to 2.
Drilling grain	do	20 to 80	0.4 to 1.8.
Mowing	do	35 to 70	0.75 to 1.5.
Raking (dump rake)	do	15 to 25	0.3 to 0.6.
Raking (side delivery)	do	20 to 40	0.4 to 0.8.
Hay loader (and wagon).	do	50 to 100	1.1 to 2.2.
Grain binder	do	60 to 100	1.3 to 2.2.
Grain header	do	50 to 80	1.1 to 1.8.
Header thresher	do	90 to 180	2 to 4.

CULTIVATION OF ROW CROPS IN AVERAGE SOIL

Operation	Draft pounds per row covered	Horsepower-hours per acre
Corn planter	130 to 300	1 to 2.5.
Corn cultivator	130 to 300	1 to 2.5.
Corn binder	300 to 600	2.5 to 5.
Corn picker	1,000 to 1,800	7.5 to 14.
Potato digger	600 to 1,000	5 to 7.5.
Stalk cutter	130 to 250	1 to 2.

HAULING

Roadbed	Draft per ton, gross load	Horsepower-hours per ton-mile, gross load
Concrete pavement	20 to 30	0.05 to 0.08.
Water-bound macadam	60 to 80	0.15 to 0.20.
Gravel (good condition)	80 to 100	0.2 to 0.25.
Earth (dry and firm)	80 to 100	0.2 to 0.25.
Hay stubble (dry)	100 to 200	0.25 to 0.5.
Corn stubble	150 to 300	0.4 to 0.8.
Plowed ground	300 to 500	0.8 to 1.3.

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Approximate power required for fa m operations—Continued

BELT OPERATIONS

Operation	Unit	Horsepower-hours per unit
Threshing wheat or rye	100 bushels	20 to 40.
Threshing oats or barley	do	10 to 25.
Threshing peas or beans	do	20 to 40.
Hulling alfalfa or clover	do	100 to 300.
Shredding corn	do	20 to 40.
Shelling corn	do	4 to 8.
Cleaning grains	do	2 to 10.
Elevating grain	do	0.2 to 0.5.
Grinding grain	do	10 to 30.
Cutting silage or feed	1 ton	0.9 to 2.5.
Baling hay or straw	do	2 to 6.
Sawing wood	1 cord	1 to 3.
Pumping water (centrifugal pump).	1,000 gallon-feet	0.005 to 0.01.
Pumping water (reciprocating pump).	do	0.01 to 0.02.

MACHINERY AND EQUIPMENT

Dust Explosions and Fires in Threshing Machines

Investigations by the Bureau of Chemistry indicate that dust explosions and fires can occur in grain-threshing machines operating in dry areas. Large losses are experienced annually from threshing-machine explosions in eastern Washington, northern Idaho, and northeastern Oregon. Effective control measures have been developed as follows: (1) A complete system of electrical connection from all the moving parts of the grain separator to a common wire will prevent a large percentage of the fires that are due to the presence of static electricity and an explosive mixture of smut dust and air. (2) A dust-collecting or suction fan installed near the cylinder will remove the dust from the front end of the separator. As it is necessary, in order for an explosion to occur, to have present in the separator an explosive mixture of dust and air, this arrangement will serve as a means for preventing the formation of such an explosive mixture. (3) An automatic fire-extinguishing equipment will afford protection irrespective of the cause of the fire or explosion. The insurance-rating bureaus have recognized the efficiency of the equipment and have allowed a reduction in rate to compensate for the expense of installation. Precautions should be adopted for the prevention of dust explosions and fires during the threshing of grain in dry areas.

Cotton-Gin Fires

The fires in cotton gins in the dry sections of Texas, Oklahoma, and Arkansas are largely due to the ignition of the cotton by sparks of static electricity produced during the operation of the gin. An effective grounding system has been developed by the engineers of the Bureau of Chemistry, and its efficiency has been recognized by the insurance companies, with a result in the reduction of premiums. The cotton ginner has it in his power to render his plant practically immune from destructive fires if he will (1) thoroughly ground all metal and moving parts of the gin, thus eliminating the static electricity; (2) educate the neighboring farmers and cotton pickers to keep the cotton as free as possible from matches and other foreign material; (3) clean the plant thoroughly at least three times a week, thus freeing the premises from lint, through which fire spreads rapidly; (4) refuse to gin wet or damp cotton, which tends to hang in the ribs and to produce friction; (5) keep the huller ribs and the gin ribs as clean as possible and the saws sharp; (6) clean out the condenser every night and immediately after all fires; (7) inspect all parts of the plant after closing, lest some hot box or smoldering cotton give rise to fire; (8) use automatic oilers on all bearings, thus preventing hot boxes and the dipping of oil from the boxes on accumulated lint or seed cotton, with the resultant spontaneous combustion, and at the same time effecting economy in the quantity of oil used; (9) store no baled cotton on the platform or at a distance less than 100 feet from any building; (10) prohibit

smoking and carrying of matches in or around the plant; (11) keep ample and efficient fire-fighting apparatus easily available at all times; (12) keep all machinery in proper alignment.

Implements Used in Grading

Steel-shod drag: Use where depth of cut or fill is not great and haul is short.

Fresno scraper: For heavy grading and moderate hauls.

Wheeled scraper: For heavy work and long hauls.

Buck scraper or planer: For slightly uneven ground.

Rectangular float or box leveler: For final smoothing.

ROADS AND BRIDGES

Bridges for Crossing Open Drainage Ditches

For railway and primary road crossings permanent structures of steel, concrete, and treated timber are required. The substructure should be so placed as to allow unobstructed waterway at times of greatest flow. Abutments should be located so as to prevent water flowing behind them as a result of erosion of the banks. Foundations should be at least 3 feet below the bed of the ditch in material other than rock, hardpan, or hard clay and should be deep enough to be below the erosive action of the current. Piers or bents should not be placed in the watercourse. The types best suited for permanent crossings are reinforced concrete box and arch culverts, slab and T-beam spans, steel girders, low trusses, and treated timber trestles.

For secondary and farm-road crossings the most usual types are simple beam spans or timber trestles. Simple beam spans are suitable for narrow ditches whose banks offer firm support for the mud sills or blocks and are subject to little erosion. Short, longitudinal mud blocks give greater and more uniform bearing area than a sill placed directly on the ground. They will last longer if placed on gravel or broken stone. A clearance of 12 inches should be provided between stringers and the ground surface to prevent decay.

Timber trestles should consist of a channel span and approach spans on each side of sufficient length to place the ends of the trestle out of range of erosion. Two spans with a bent at or near the center of the ditch should not be used because of the obstruction to flow. Single-span trestles with timber back walls should not be used, because the back walls decay rapidly, causing excessive maintenance cost.

The floor system of a timber trestle may be supported on either pile or frame bents, but pile bents are seldom economical on small jobs. Frame bents consist of three or more posts, a cap, and a sill which may be placed directly on the ground on mud blocks or on concrete piers or pedestals. They should be provided with double bracing bolted at the ends to the cap and sill and at intermediate points to each post. The caps and sills should be dapped to receive the ends of the posts, to which they should be securely drift-bolted. The sills should also be anchored to concrete piers or pedestals by means of bolts placed in masonry and extending into the sill. Concrete foundations should be high enough to keep the timber sills above the ordinary water level and have sufficient bearing area at the bottom to prevent settlement.

Stringers should be spaced not greater than 27 inches center to center and preferably between 18 and 24 inches. The inside stringers should have full bearing on the caps and be separated at the laps in order to avoid the retention of moisture between them. The outside stringers may be placed end to end over the center line of the cap. Double 2 by 4 inch bridging should be used when the width of stringer is less than one-third the depth. Spans under 15 feet should have one line of bridging; 15 to 20 foot spans, two lines; above 20 feet, three lines.

Floor planks should be spiked to each stringer and have a thickness of not less than 3 inches for highway crossings or 2 inches for private crossings, but preferably 3 inches for a 5-ton loading.

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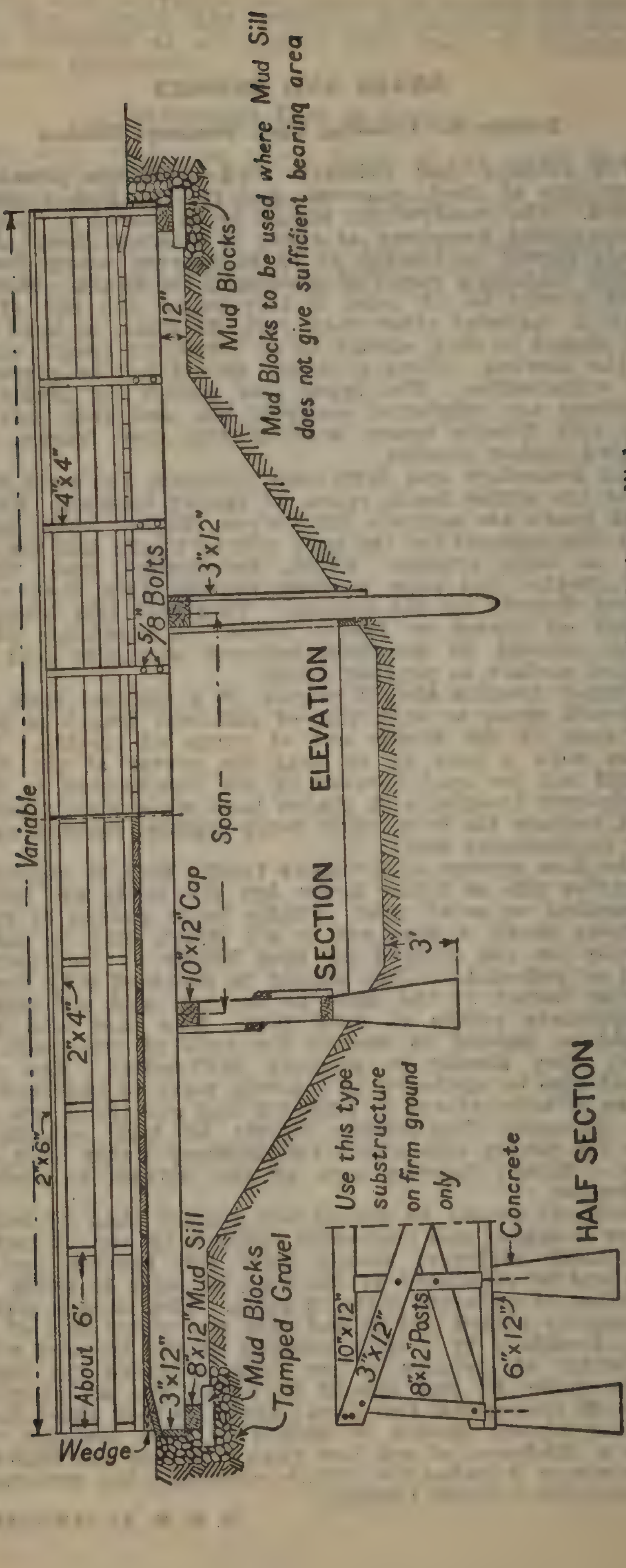
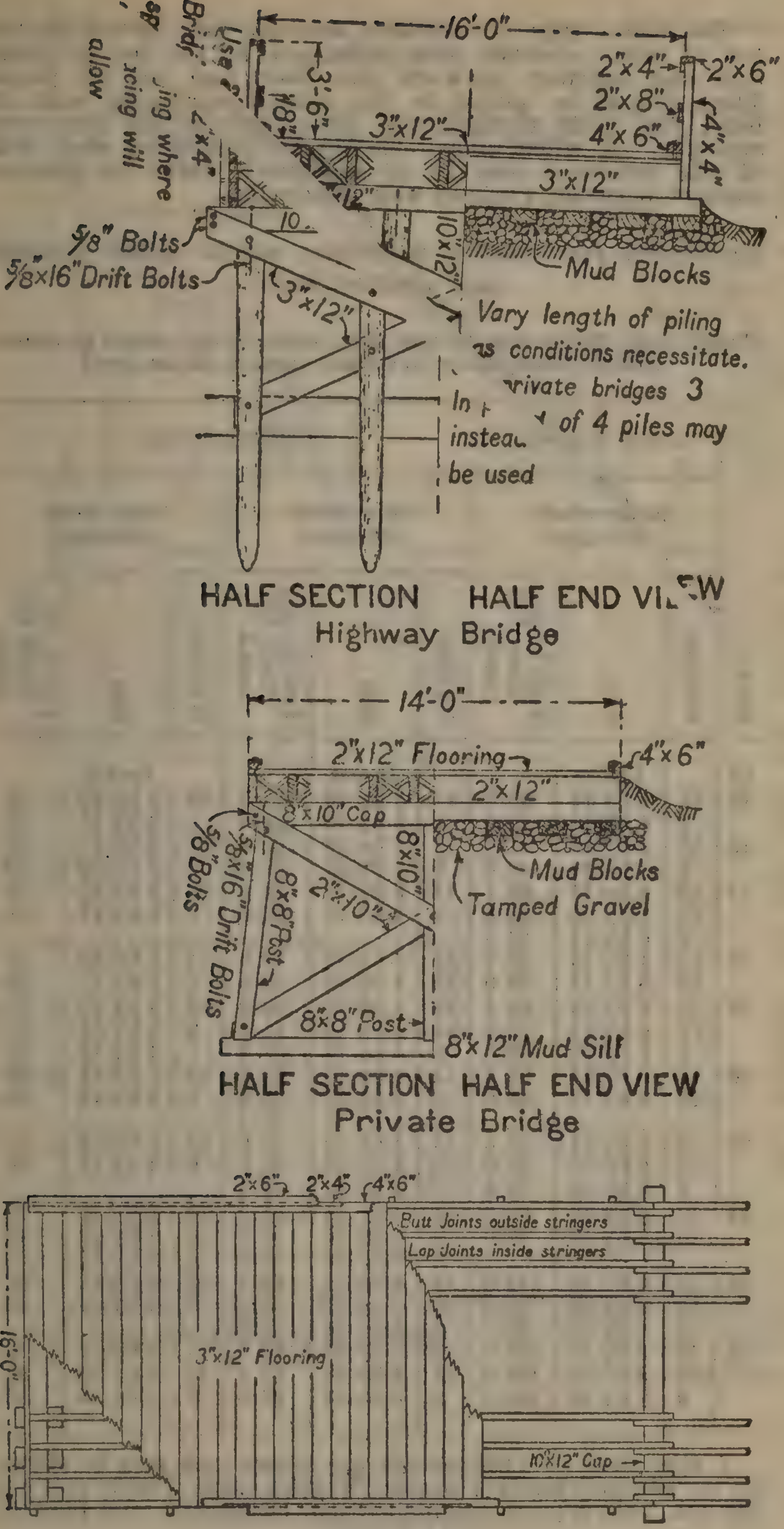


(A) Timber bridge suitable for crossing drainage ditch



(*B*) Timber bridge suitable for crossing drainage ditch

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The usual type of handrail has one rail spiked to the top of posts and two side rails, one at the top of posts and one halfway between the floor and top of posts. They should be bolted to the outside stringers with at least two bolts through the lower end of the post and stringer. A wheel guard should be placed on each side of the roadway and be of sufficient width to prevent contact between vehicles and handrails.

Stringers for timber trestles; stress 1,200 pounds per square inch

[Truck load, 80 per cent on rear axle; axles, 12 feet center to center; wheels, 6 feet center to center; impact, 30 per cent]

Span	16-foot roadway			14-foot roadway					
	10-ton truck: Stringers			5-ton truck: Stringers			3-ton truck: Stringers		
	Number	Size	Feet b. m., linear feet trestle	Number	Size	Feet b. m., linear feet trestle	Number	Size	Feet b. m., linear feet trestle
Ft.		*Inches*			*Inches*			*Inches*	
10	12	4 by 12	48.0	11	3 by 10	27.5	10	2 by 10	16.7
	9	4 by 14	42.0	8	3 by 12	24.0	7	3 by 10	17.5
12	11	4 by 14	51.3	13	3 by 10	32.5	12	2 by 10	20.0
	9	4 by 16	49.0	9	3 by 12	27.0	8	3 by 10	20.0
14	13	4 by 14	60.7	11	3 by 12	33.0	10	3 by 10	25.0
	10	4 by 16	53.3	8	4 by 12	32.0	7	3 by 12	21.0
	9	6 by 14	63.0						
16	11	4 by 16	58.7	12	3 by 12	36.0	11	3 by 10	27.5
	10	6 by 14	70.0	10	4 by 12	40.0	8	3 by 12	24.0
18	13	4 by 16	69.3	13	3 by 12	39.0	13	3 by 10	32.5
	11	6 by 14	77.0	11	4 by 12	44.0	9	3 by 12	27.0
	9	6 by 16	72.0	8	4 by 14	37.3	7	4 by 12	28.0
20	13	6 by 14	91.0	12	4 by 12	48.0	10	3 by 12	30.0
	10	6 by 16	80.0	9	4 by 14	42.0	8	4 by 12	32.0
				7	4 by 16	37.3			
22	14	6 by 14	98.0	13	4 by 12	52.0	12	3 by 12	36.0
	11	6 by 16	88.0	10	4 by 14	46.7	9	4 by 12	36.0
	8	6 by 18	72.0	8	4 by 16	42.7			
24	12	6 by 16	96.0	11	4 by 14	51.3	13	3 by 12	39.0
	10	6 by 18	90.0	9	4 by 16	48.0	10	4 by 12	40.0
				8	6 by 14	56.0	8	4 by 14	37.3
26	14	6 by 16	112.0	13	4 by 14	60.7	12	4 by 12	48.0
	11	6 by 18	99.0	10	4 by 16	53.3	9	4 by 14	42.0
	8	8 by 18	96.0	9	6 by 14	63.0			
28	12	6 by 18	108.0	13	4 by 14	60.7	13	4 by 12	52.0
	12	8 by 16	128.0	11	4 by 16	53.3	10	4 by 14	46.7
	9	8 by 18	108.0	9	6 by 14	63.0	8	4 by 16	42.7

A fiber stress of 1,200 pounds per square inch may be allowed for the following kinds of timber: Western larch, Pacific post oak, bur oak, bald cypress, mountain-region Douglas fir, and redwood.

Stringers for timber trestles; stress 1,600 pounds per square inch

[Truck load, 80 per cent on rear axle; axles, 12 feet center to center; wheels, 6 feet center to center; impact, 30 per cent]

	16-foot roadway			14-foot roadway					
	10-ton truck: Stringers			5-ton truck: Stringers			3-ton truck: Stringers		
Span	Number	Size	Feet b. m., linear feet trestle	Number	Size	Feet b. m., linear feet trestle	Number	Size	Feet b. m., linear feet trestle
Ft.		*Inches*			*Inches*			*Inches*	
10	12	3 by 12	36.0	12	2 by 10	20.0	8	2 by 10	13.3
	9	4 by 12	36.0	8	3 by 10	20.0	----	---------	-------
12	11	4 by 12	44.0	10	3 by 10	25.0	9	2 by 10	15.0
	9	4 by 14	42.0	7	3 by 12	21.0	----	---------	-------
14	13	4 by 12	52.0	11	3 by 10	27.5	11	2 by 10	18.3
	10	4 by 14	46.7	8	3 by 12	24.0	7	3 by 10	17.5
	8	4 by 16	42.7	----	---------	-------	----	---------	-------
16	11	4 by 14	51.3	13	3 by 10	32.5	12	2 by 10	20.0
	9	4 by 16	48.0	10	3 by 12	30.0	9	3 by 10	22.5
	----	---------	-------	8	4 by 12	32.0	----	---------	-------
18	13	4 by 14	60.7	11	3 by 12	33.0	10	3 by 10	25.0
	9	6 by 14	63.0	8	4 by 12	32.0	7	3 by 12	21.0
	10	4 by 16	53.3	----	---------	-------	----	---------	-------
20	10	6 by 14	70.0	12	3 by 12	36.0	11	3 by 10	27.5
	14	4 by 14	65.3	9	4 by 12	36.0	8	3 by 12	24.0
	11	4 by 16	58.7	7	4 by 14	32.7	----	---------	-------
22	12	4 by 16	64.0	13	3 by 12	39.0	12	3 by 10	30.0
	11	6 by 14	77.0	10	4 by 12	40.0	9	3 by 12	27.0
	8	6 by 16	64.0	8	4 by 14	37.3	----	---------	-------
24	13	4 by 16	69.3	11	4 by 12	44.0	14	3 by 10	35.0
	11	6 by 14	77.0	9	4 by 14	42.0	10	3 by 12	30.0
	9	6 by 16	72.0	----	---------	-------	8	4 by 12	32.0
26	13	6 by 14	91.0	13	4 by 12	52.0	11	3 by 12	33.0
	10	6 by 16	80.0	10	4 by 14	46.7	9	4 by 12	36.0
	8	6 by 18	72.0	8	4 by 16	42.7	----	---------	-------
28	14	6 by 14	98.0	11	4 by 14	51.3	12	3 by 12	36.0
	11	6 by 16	88.0	8	4 by 16	42.7	10	4 by 12	40.0
	9	6 by 18	81.0	7	6 by 14	49.0	----	---------	-------
	9	8 by 16	96.0	----	---------	-------	----	---------	-------

A fiber stress of 1,600 pounds per square inch may be allowed for the following kinds of timber: Tanbark oak, white oak, Cuban pine, long-leaf pine, coast-region Douglas fir, and short-leaf pine (treated).

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Wire nails: Kinds and quantities required

Length (inches)	Approximate number to a pound	Nailings	Sizes and kinds of material (inches)	Trade names [1]	Pounds per 1,000 feet b. m. studs on center				
					12	16	20	36	48
2½	106	2	1 by 4	8d c.	60	48	37	23	20
2½	106	2	1 by 6	8d c.	40	32	25	16	13
2½	106	2	1 by 8	8d c.	31	27	20	12	10
2½	106	2	1 by 10	8d c.	25	20	16	10	8
2½	106	3	1 by 12	8d c.	31	24	20	12	10
4	31	2	2 by 4	20d c.	105	80	65	60	33
4	31	2	2 by 6	20d c.	70	54	43	27	22
4	31	2	2 by 8	20d c.	53	40	53	21	17
4	31	3	2 by 10	20d c.	60	50	40	25	20
4	31	3	2 by 12	20d c.	52	41	33	21	17
6	11	2	3 by 4	60d c.	197	150	122	76	61
6	11	2	3 by 6	60d c.	131	97	82	52	42
6	11	2	3 by 8	60d c.	100	76	61	38	34
6	11	3	3 by 10	60d c.	178	137	110	70	55
6	11	3	3 by 12	60d c.	145	115	92	58	46
2½	189	2	Base, per 100 feet	8d fin.	----	1	----	----	---
2½	106	2	Byrket lath	8d c.	----	48	----	----	---
2½	189	1	Ceiling, ¾ by 4	8d fin.	18	14	----	----	---
2	309	1	Ceiling, ½ and ⅝	6d fin.	11	8	----	----	---
2½	189	2	Finish, ⅞	8d fin.	25	12	----	----	---
3	121	2	Finish, 1⅛	10d fin.	12	10	----	----	---
2½	99	1	Flooring, 1 by 3	8d f. b.	42	32	----	----	---
2½	99	1	Flooring, 1 by 4	8d f. b.	32	26	----	----	---
2½	99	1	Flooring, 1 by 6	8d f. b.	22	18	----	----	---
4	31	...	Framing 2 by 4–2 by 16 requires 3 or more sizes.	20d c.	20	16	14	----	---
3½	49			16d c.	10	10	8	----	---
3	69			10d c.	8	6	5	----	---
6	11		Framing, 3 by 4–3 by 14	60d c.	30	25	20	----	---
2½	145	2	Siding, drop, 1 by 4.	8d ca.	45	35	----	----	---
2½	145	2	Siding, drop, 1 by 6.	8d ca.	30	25	----	----	---
2½	145	2	Siding, drop, 1 by 8.	8d ca.	23	18	----	----	---
2	309	1	Siding, bevel, ½ by 4.	6d fin.	23	18	----	----	---
2	309	1	Siding, bevel, ½ by 6.	6d fin.	15	13	----	----	---
2	309	1	Siding, bevel, ½ by 8.	6d fin.	12	10	----	----	---
	------	----	Casing, per opening.	6d & 8d ca.	About ½ pound per side.				
1¼	568	[2] 12	Flooring, ⅜ by 2	3d b.	About 10 pounds per 1,000 square feet.				
1⅛	778	[2] 16	Lath, 48-inch	3d fin.	6 pounds per 1,000 pieces.				

[1] c., common; fin., finish; f. b., floor brads; ca., casings; b., brads.
[2] Inches on centers.

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Wire nails: Kinds and quantities required—Contd.

Length (inches)	Approximate number to a pound	Nailings	Sizes and kinds of material (inches)	Trade names [1]	Pounds per 1,000 feet b. m. studs on center				
					12	16	20	36	48
⅞	469	[2] 2	Ready roofing	b. r.	¾ pound per square.				
⅞	469	[2] 1	do	b. r.	1½ pounds per square.				
⅞	180	[2] 2	Ready roofing (⅝ heads).	f. r.	1½ pounds per square.				
⅞	180	[2] 1	do	f. r.	3 pounds per square.				
1¼	429	[2] 2	Shingles [3]	3d sh.	4½ pounds.				
1½	274	[2] 2	do	4d sh.	7½ pounds.				
⅞	180	4	do	f. r.	12 pounds, ⅝-inch heads.				
⅞	469	4	do	b. r.	4½ pounds, ⅝-inch heads.				
1	1,150	[2] 2	Wall board around entire edge.	2d b. b.	5 pounds, ⅝-inch heads per 1,000 square feet.				
1	1,010	[2] 3	Wall board intermediate nailings.	2d ca.	2½ pounds, ⅝-inch heads per 1,000 square feet.				

[1] b. r., barbed roofing; f. r., felt roofing; sh., shingle; b. b., barbed berry; ca., casings.
[2] Inches on centers.
[3] Wood shingles vary in width; asphalt shingles are usually 8 inches wide. Regardless of width, 1,000 shingles are the equivalent of 1,000 pieces 4 inches wide.

Paint

Paint is a liquid coating consisting essentially of a pigment and a vehicle. The pigment is an insoluble opaque solid or mixture of solids in finely powdered form, which gives the covering and coloring properties. The vehicle is a liquid or mixture of liquids which holds the solid particles in suspension, makes possible their transference to and spreading over a solid surface, and, upon drying, serves to bind them to the surface and to one another. In oil paints the vehicle consists essentially of linseed or other drying oils. Such paints dry by oxidation of the oil. In flat-finish oil paints the vehicle consists of a small quantity of drying oil and a large quantity of volatile thinner, such as turpentine. During and after the evaporation of the thinner the oil dries by oxidation and holds the pigment in place. In enamel paints the vehicle is varnish, which dries partly by evaporation and partly by oxidation. In water paints, such as whitewash, calcimine, and cold-water paint, the vehicle consists essentially of water. Adhesive substances, such as glue and casein, are frequently added. Water paints dry by evaporation alone. In bituminous paints the vehicle consists of a volatile solvent and the soluble portion of some bituminous material like coal tar or asphalt. In oil paints and enamels the pigment consists essentially of insoluble metallic compounds, carbon, and siliceous minerals. The principal white pigments are white lead, zinc oxide, and lithopone. The principal colored pigments are iron oxide, red lead, earth pigments,

chrome yellow, Prussian blue, ultramarine, and lampblack. In bituminous paints the vehicle itself is colored, and for that reason a finely divided mineral substance, even though lacking in opacity or color, may be used as a filler. In water paints the principal white or base pigments consist of hydrated lime, carbonate of lime (whiting), and sulphate of lime (gypsum). Any dry colored pigment may be used in tinting except those affected by lime, such as Prussian blue and chrome green. Water paints may be used indoors for decoration, illumination, and sanitation.

For outside house painting, gloss-finish oil paints are used most extensively. In such paints the base pigment may be white lead, or a mixture of white lead, zinc oxide, and a small quantity of siliceous mineral. Various pigments may be used for tinting, but lampblack, iron oxide, and the earth pigments are the most permanent. The important points about house paints are that whatever pigments are used should be very finely divided and that only pure linseed oil should be used as the binder. Excessive quantities of thinner and drier should be avoided.

The quantity of paint required varies with the nature of the surface to be covered and the condition under which it is applied. Generally allow 400 to 500 square feet of surface to each gallon of paint per coat (600 to 800 square feet for metal surfaces).

Paints composed of several pigments wear better than the one-pigment paints. Also, the darker shades wear better than the lighter ones.

High-grade paint usually contains from 62 to 65 per cent pigment, the balance being liquids, of which 90 per cent is linseed oil and 10 per cent turpentine or similar thinner or drier. The use of inert pigments such as asbestine, silica, and whiting is not objectionable and at times is beneficial, but more than 15 per cent of such material should not be used.

A mixture of 40 pounds of white lead and 20 pounds of white zinc is more durable for outside work than straight white lead. Zinc white alone is not suitable for outside work. The oxide-of-iron pigments are cheap and durable and very satisfactory for farm structures; they are used without white lead or zinc. Lead paints will darken if not exposed to bright light or if subjected to the fumes of decaying organic matter.

14 pounds of dry white lead and 7½ pounds of vehicle=1 gallon.

15 pounds of white-lead paste and 6½ pounds of vehicle=1 gallon.

9½ pounds of zinc white and 5¾ pounds of vehicle=1 gallon.

Ordinary paint can be used on concrete surfaces if the alkali is neutralized by the washing of the wall with a solution of 3 pounds of zinc-sulphate crystals and 1 gallon of water.

Galvanized-iron surfaces should first be roughened by brushing with a solution of 4 ounces of copper sulphate, chloride, or acetate, and 1 gallon of water. About one hour after applying, dust off the surface and paint with a good metal paint.

Red lead, Venetian red, or other inhibitive pigments should be used for the first coat on metal. The color may be darkened with lampblack. Tin roofs should be cleaned of grease by being washed with benzine and then painted; red oxide of iron is a satisfactory pigment. The under side should be painted before erection. Bituminous paints and enamels are good for waterproofing masonry. Paints

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made from coal tar or asphalt are also good for refinishing composition roofs originally treated with similar materials.

Always paint on dry and seasoned surfaces. Warm, dry weather is the best time.

Whitewash

Government Formula.—Slake one-half bushel of quicklime or lump lime with boiling water, keeping it covered during the process; strain, and add 1 peck of salt dissolved in warm water. Boil 3 pounds of ground rice in water to a thin paste; dissolve in warm water one-half pound of Spanish whiting and 1 pound of clear glue; mix these well together and let the mixture stand for several days. Keep the wash thus prepared in a kettle or portable furnace and when used put it on as hot as possible with a brush.

Light House Whitewash.—

(1) 62 pounds (1 bushel) of quicklime; slake with 12 gallons of hot water.

(2) 12 pounds of rock salt; dissolve in 6 gallons of water.

(3) 6 pounds of Portland cement.

(4) Pour (2) into (1) and then add (3).

One ounce of alum to each gallon of whitewash increases its adhesion.

One pint of molasses added to 5 gallons of whitewash increases the penetration on wood and plaster.

Whitewash may be made fire resistant by adding 1 part of water glass (35° Baumé) to 10 parts of whitewash.

A gloss similar to that of oil paint may be obtained by adding 1 pound of cheap bar soap dissolved in 1 gallon of boiling water to every 5 gallons of whitewash.

Add 4 to 6 pounds of ochre to each bushel of lime to get a cream color.

Add 6 to 8 pounds of raw umber and 3 or 4 pounds of lampblack to produce a buff.

Add 6 to 8 pounds of umber, 2 pounds of lampblack, and 2 pounds of Indian red for fawn.

Siennas, umbers, Venetian red, maroon oxide, ultramine blue, and chrome oxide can be used to color whitewashes.

Waterproof Calcimine.—Heat 1 pound of casein in 1 pint of cold water and dilute the mixture with 3 quarts of cold water and 8 fluid ounces of ammonia. Stir the whole solution until a smooth jelly is formed, then add one-fourth ounce of formaldehyde. Add hydrated lime until a fairly thick paste is formed. Dilute with water, alcohol, turpentine, or linseed oil to consistency of paint. Calcimine can be colored with pigments used for whitewash.

Mortar and Masonry

Legal lime barrels hold 280 and 180 pounds of lime. A 280-pound barrel equals 3½ bushels at 80 pounds per bushel. One cubic foot of lime weighs 64 pounds. Lump lime swells about 2.62 times in bulk when wet. One 180-pound barrel of lumps yields about 8 cubic feet of paste or putty.

A strong mortar is made by mixing 50 pounds of cement, 20 pounds of hydrated lime, and 300 pounds of sand.

One barrel of Portland cement and 3 barrels of sand make about 12 cubic feet of mortar, which is sufficient to

lay up 1½ cubic yards of rough stonework or 750 bricks, or will spread over 125 square feet of surface 1 inch thick.

Two and one-half bushels of lump lime and five-eighths cubic yard of sand are required in laying 1,000 bricks.

Two bushels of lump lime, 1 barrel of cement, and five-eighths cubic yard of sand are required in laying 1,000 bricks.

One thousand bricks closely spaced can be stacked in 56 cubic feet, but 72 cubic feet will be required to stack loosely 1,000 old bricks after old mortar is removed.

Allow seven and one-half bricks per square foot surface of wall for each 4 inches of thickness.

Concrete

The proportions indicated below are recommended for various classes of work:

1 : 1½ : 3 or 1 : 2 : 3 mixtures used for concrete subject to high stresses or where exceptional water-tightness and resistance to abrasion are desired, as one-course highways, fence posts, and water tanks.

1 : 2 : 4 mixture used for general reinforced and water-tight work, as beam and slab construction, watering troughs, silos, feeding floors, and dipping vats.

1 : 2½ : 5 or 1 : 3 : 5 mixtures used for plain concrete of moderate strength, as base of two-course pavings, foundation walls, backing of concrete blocks.

1 : 2 mixture used for wearing courses of pavements, stucco work, facing of blocks.

1 : 2½ mixture used for fence posts without large aggregate, stucco finish, mortar for masonry.

1 : 3 mixture used for tiles and blocks without large aggregate and mortar.

It is advisable to separate bank-run gravel into two parts and remix the fine and coarse parts as provided for above. Sift over a ¼-inch mesh screen and consider the material passing through as sand and the material retained as gravel. Where the proportion of sand to gravel is correct and the bank run is uniform consider a 1 : 4½ mixture equivalent to 1 : 2 : 4, a 1 : 5½ mixture equivalent to 1 : 2½ : 5, and a 1 : 7 mixture equivalent to 1 : 3 : 6. Where sand predominates in bank run, and coarse aggregate is difficult to obtain, the mixture should not be leaner than 1 part cement to 3 parts of the sand content of the bank run.

Materials for 1 cubic yard of rammed concrete

Proportion			Quantity		
Cement	Sand	Gravel	Cement	Sand	Gravel
			Sacks	*Cu. yds.*	*Cu. yds.*
1	1	--------	19.20	0.74	--------
1	2	--------	13.48	1.00	--------
1	2½	--------	11.00	1.01	--------
1	3	--------	10.40	1.16	--------
1	1	2	10.52	.39	0.78
1	1½	3	7.64	.42	.85
1	2	4	6.04	.45	.89
1	2½	5	4.96	.46	.92
1	3	5	4.64	.52	.86
1	3	6	4.24	.47	.94

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Space Required for Farm Animals

Horse Barns.—Length of platform, 7 to 8 feet (allow 15 feet from front of manger to back of litter alley); width of stall, single, 4 feet 6 inches for under 1,600 pounds and 5 feet for over; double stall, 8 feet for under 1,200 pounds and 9 feet for over. Manger, 2 feet wide, 3 feet high; ceiling, about 9 feet high; doors, 4 to 9 feet. Feed alley, 4 to 6 feet for tie stalls. Box stalls, 10 by 12 feet, minimum; 12 by 12 feet, average.

Mule Barns.—

Size of animal	Trough space		Space per head	
	Minimum	Desirable	In shed	In lot
	Inches	*Inches*	*Square feet*	*Square feet*
Weanlings, 425 to 500 pounds	20 to 24	24 to 30	40 to 50	50 to 140
Mature, 900 to 1,400 pounds	34 to 38	38 to 46	60 to 70	70 to 210

Dairy-Cattle Barns.—

Breed	Width	Gutter edge to curb					
		Small		Medium		Large	
	Ft. in. Ft. in.	*Ft.*	*in.*	*Ft.*	*in.*	*Ft.*	*in.*
Holstein	3 6 to 4 0	4	10	5	2	5	8
Shorthorn	3 6 to 4 0	4	8	5	0	5	6
Ayrshire	3 6 to 3 8	4	6	5	0	5	6
Guernsey	3 4 to 3 6	4	6	4	10	5	4
Jersey	3 4 to 3 6	4	4	4	8	5	0
Heifers	2 9 to 3 2	3	8	5	10	4	2

Ceiling height average, 8 feet; manger, 2 feet to 2 feet 6 inches; gutter, 18 inches wide, not over 8 inches deep; suggested litter alley, 3 feet 6 inches to 4 feet facing in, 7 feet minimum facing out; doors, 3 feet 6 inches to 4 feet; box stall, minimum, 8 by 10 feet.

Beef-Cattle Barns.—Floor space, 40 square feet per 1,000 pounds live weight; doors, 4 to 8 feet; ceiling, 8 feet.

Sheep Barns.—Floor space, 12 square feet for breeding ewes; 6 square feet for fattening lambs. Trough space, 15 to 17 inches.

Hog Houses.—Farrowing pen, young sow, 48 square feet; aged sow, 56 to 64 square feet. Doors, 24 by 32 inches (minimum); alley, 4 feet or wider. Trough space, single side, 15 inches; double side, 12 inches.

Poultry Houses.—Floor area, 2½ to 5 square feet (small flocks, 4 square feet). Yard allowance per bird, 20 to 30 square feet. Roost length per hen, 7 to 10 inches, 15 inches apart. Nest, 12 inches square (minimum), 15 inches preferred, and 5 or 6 inches deep, 1 to 4 or 5 hens. Coal hover, 52 inches in diameter, will hover 250 to 300

chicks. Exhibition pen, 4 hens and 1 cock, 24 by 24 by 24 inches. House space for ducks, 6 to 7 square feet. Fences, 2 to 2½ feet high.

Estimating Feed in Storage

Hay Barns and Sheds—*Measuring hayricks.*—The volume of a rick is equal to its length multiplied by the area of its cross section. It is difficult to measure accurately the height of a rick. It is much easier to measure the "over," which is the distance from the ground on one side of the rick over the top of the rick to the ground on the other side. The length of the over depends upon three things: (1) Width, (2) height, and (3) "fullness" of the rick. The over is always somewhat more than twice the height. It has been found by actual measurement that the cross section of a rick is the product of the over and the width, multiplied by a fraction varying from 0.25 to 0.37 (average, 0.31), depending upon the height and fullness of the rick. Representing this fraction by F, the over by O, the width by W, and the length of the rick by L, the volume being represented by V, we have the following formula for determining the number of cubic feet in a rick:

$$\text{Volume}=\text{Fraction}\times\text{Over}\times\text{Width}\times\text{Length},$$

or, as commonly written,

$$V=F\ O\ W\ L.$$

Quartermaster's rule.—Add the over and the width and divide by 4; multiply the result by itself and then by the length; the result will be the volume in cubic feet.

Frye-Bruhm rule.—Subtract the width from the over and divide by 2; multiply by the width and then by the length; the result will be the volume in cubic feet.

The Frye-Bruhm and the Quartermaster's rules usually divide the volume by 512 to get the total number of tons.

Hay in Mow.—Allow 450 to 500 cubic feet for storing 1 ton of hay in the mow.

Corncribs, Granaries, and Seed Rooms.—To find the number of bushels of grain or shelled corn in a bin multiply the length by the width by the average depth (all in feet) and divide by 1¼. If the crib is round, multiply the distance around the crib by the diameter by the depth (all in feet) and divide by 5. Allow 2 bushels of ear corn to make 1 of shelled.

Dust Explosions in Grain Elevators

The Department of Agriculture has for some time been conducting studies relative to the causes and prevention of dust explosions in grain mills, elevators, and similar plants. The close relation of thresher explosions to the general study of grain-dust explosions led to the undertaking of a special study of this allied problem in the northwestern part of the United States. As a result of this study 166 occurrences were investigated and reported. Previous investigations relative to the causes of explosions indicated that static electricity was a possible factor in the production of dust explosions. While investigations were being conducted two slight explosions occurred on a dry, frosty morning in early fall, in two separate plants, at a time when the feed had been shut off from certain grinding machines. Both occurrences took place a considerable time after the grain had stopped en-

tering the machines. The possibility of static electricity being generated in the operation of the revolving plates of the machine suggested itself in a preliminary way at the time of these explosions. Although no record could be found that experiments had been conducted to determine whether cereal dusts could be ignited in this manner, it was found by experiment that sufficient static electricity could be generated by the friction of a very small pulley and belt to ignite natural gas readily. It was learned that a milling company in the South engaged in grinding cottonseed cake into meal, after experiencing a series of explosions, had prevented a repetition of these occurrences by grounding the machine by means of a wire connected to a rod driven into the ground. This seemed to confirm the original theory and indicated the value of a grounding device of this kind.

Silos.—

Capacity of round silos (Nebraska)

Height (feet)	Inside diameter					
	10 feet	12 feet	14 feet	16 feet	18 feet	20 feet
	Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
20	22.78	32.75	44.60	58.28	73.80	91.10
24	29.50	42.45	57.80	75.48	95.53	117.95
26	33.08	47.66	64.80	84.64	107.22	132.30
28	36.78	53.00	72.10	94.10	119.25	147.10
30	40.60	58.50	79.50	103.80	131.60	162.30
32		64.12	87.20	113.80	144.35	178.00
34		69.82	95.10	124.20	157.35	194.10
36			103.20	134.70	170.70	210.60
38			111.30	145.30	184.20	227.20
40			119.60	156.20	198.10	244.30
44				178.60	226.30	279.10
48				201.80	255.65	315.40

Feeding capacities of silos (Iowa)

Inside diameter of silo (feet)	Silage in depth of 2 inches	Number of animals that may be fed, allowing daily—				
		40 pounds per head	30 pounds per head	20 pounds per head	10 pounds per head	4 pounds per head
	Pounds					
10	524	13	17	26	52	130
12	754	19	25	37	76	190
14	1,026	25	34	51	100	250
16	1,340	33	44	67	132	330
18	1,696	42	56	85	168	420
20	2,094	52	70	104	208	520

Painting inside of silos.—Four pounds of paraffin dissolved in one-half gallon of gasoline or naphtha will make 1 gallon of solution which will cover 200 square feet of a dry concrete surface. Paraffin can be applied in melted form. When melted, 6½ pounds of paraffin make 1 gallon and will cover 250 square feet. A blowtorch should be used to warm the walls and also to spread the paraffin.

A coating of coal tar dissolved in gasoline is sometimes used.

Implement Houses

Floor space and height of space required to house farm implements [1]

Implement	Floor space	Height of space
Automobiles:	*Feet*	*Feet*
Small	6 by 11	7
Large	7 by 16	8
Binders:		
Grain, 8 feet (tongue truck off)	8 by 14	7
Grain, 6 feet (tongue truck off)	8 by 12	7
Corn (tongue off; add 11 feet for tongue)	7 by 12	7
Buggies:		
One-seated (thills up)	6 by 8	7
Two-seated (tongue off)	6 by 10	8
Clover huller	8 by 24	8
Corn planter, 2-row (tongue off; add 10 feet for tongue)	5½ by 6	3½
Corn sheller, 2-hole, power	4 by 6	7
Corn shredder, 8-roll	8 by 20	9
Cultivators:		
Walking, 1-horse	2 by 7	3½
Riding, single-row (add 10 feet for tongue on)	5 by 8	4
Riding, 2-row (tongue off; add 10 feet for tongue)	8 by 10	4
Silage cutter, 20-ton (tongue off)	5 by 11	7
Fanning mill, 24-inch	4 by 3½	5
Grain drills:		
12 by 7 (tongue off; add 10 feet for tongue)	5 by 8	5
16 by 7 with press attachment (tongue off)	7 by 11	5
Grain dump (knocked down)	4 by 14	5
Grain separator, 20-inch cylinder	8 by 26	9
Harrows:		
Spike tooth (hung on walls)		
Spring tooth, per section	5 by 4	1½
Single disk, 8 feet with truck (tongue off)	6 by 9	4
Double disk, 7 feet with truck (tongue off)	8 by 8	4
Hay loader	9½ by 14	9
Hay rakes:		
Self-dump (thills off)	5½ by 11½	5
Side-delivery (tongue off; add 10 feet for tongue)	9 by 13	5
Manure spreader, 70-bushel (add 10 feet for tongue on).	7 by 16	6
Mower, 6 feet (tongue off; add 10 feet for tongue)	5 by 6	7
Lister:		
Narrow tread, tongue off	5 by 9	5
Wide tread, tongue off	9 by 9	5
Lister, cultivator:		
Single-row, tongue raised	5 by 8	5
2-row, tongue raised	8 by 11	5

[1] From Kansas Eng. Expr. Sta. Bul. 101.

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Floor space and height of space required to house farm implements—Continued

Implement	Floor space	Height of space
	Feet	*Feet*
Phosphorus distributor, 1,000-pound (add 10 feet for tongue).	4 by 10	4
Plows:		
Walking	3 by 7	3
Sulky and horse gang (add 10 feet for tongue on).	8 by 6	4
Engine gang, 3-bottom	6 by 9	4
Portable engine, 6-horsepower	5 by 9	6
Potato machinery:		
Planter (tongue off; add 9 feet for tongue)	4 by 6	4
Sprayer, 2-wheeled barrel (thills off)	6 by 6	6
Digger, wheeled, elevator (tongue off)	5 by 12	5
Rollers:		
Smooth	5 by 10	4½
Corrugated, single (add 10 feet for tongue on)	3 by 10	4
Corrugated, double	4 by 8	4
Tedders:		
Kicker (tongue off; add 8 feet for tongue)	5½ by 8	5
Combination (see Hay rakes, side-delivery).		
Tractors:		
20 to 40 horsepower	9 by 15	9
10 to 20 horsepower	8 by 12	8
Wagons:		
Farm gear (tongue off; add 10 feet for tongue)	6 by 11	4
Wagon with box and top (tongue off)	6 by 11	5½
Wagon with box and tiptop (tongue off)	6 by 11	6½
Wagon with hay rack (tongue off)	8 by 16	5
Weeder (thills on)	13 by 8	4

Ice Houses

About 40 cubic feet of space is required to store 1 ton of ice.

About 50 per cent more should be stored than needed.

About one-half to 1 ton allowed per cow for cooling cream only and 1½ to 2 tons per cow if whole milk is cooled.

One cubic foot solid ice weighs about 57 pounds.

Standard block of manufactured ice is 11 by 22 by 44 inches and weighs 300 pounds.

Shipping Crates

Sheep.—1 foot 9 inches by 4 feet 0 inches by 2 feet 0 inches high.

Cow.—3 feet 2 inches by 8 feet 6 inches by 5 feet 1 inch high (2 feet 2 inches in front of stanchion).

Regulations of express and freight companies should be complied with.

Dimensions of shipping crates

POULTRY (EXHIBITION)

Number	Dimensions of crate
1 hen	12 by 18 by 24 inches high.
2 hens	12 by 24 by 24 inches high.
3 hens	18 by 24 by 24 inches high.

HOGS

Weight	Dimensions of crate								
	Ft.	*in.*		*Ft.*	*in.*		*Ft.*	*in.*	
Up to 100 pounds	1	0	by	3	10	by	2	0	high.
150 to 175 pounds	1	8	by	4	2	by	2	1	high.
250 pounds	2	0	by	5	2	by	2	10	high.
500 pounds	2	9½	by	6	8	by	4	0	high.

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STRUCTURAL EQUIPMENT

Sanitation and Water Supply

Septic Tanks and Filters.—A septic tank is a tight receptacle through which sewage passes slowly, causing some of the solids to settle and ultimately to decompose or to rot. The escaping liquid is foul and dangerous, but generally contains less solid matter than the raw sewage. Hence it does not so quickly clog the pores of a filter or soil. Any kind of sewage tank is merely an aid to filtration, which alone brings about real purification.

The most suitable filter for the average farmer is one or more gently sloping lines of 3 or 4 inch draintile laid with open joints 10 to 15 inches below the surface of sandy, gravelly, or other porous, well-drained ground below and 300 feet from the source of water supply. The accompanying diagram shows a method of laying the tile. The joints are open one-eighth to one-fourth of an inch, and the tops are covered with strips of tarred paper to keep out dirt. Sewage escapes at the bottom of the joints. Clay and other compact soils should be made mellow by subsoiling and underdraining, and the tile should be surrounded with coarse sand or gravel. Good drainage and plenty of air in the soil are vital.

Installation for level ground.—One-chamber septic tank as shown in accompanying diagram; water-tight concrete, brick, or stone construction to hold 24 hours' flow of sewage, usually about 40 gallons per person; 4-inch sewer from tank to house, laid uphill with hubs ahead and the joints cemented or grouted to prevent leakage and to keep out roots; to get fall, it may be necessary to have sewer and top of tank above the ground embanking both to protect from frost; 4-inch outlet submerged to mid-depth of tank; effluent wasted as shown in the diagram.

Capacity and inside dimensions of one-chamber tanks

Number of persons	Sewage per day	Capacity below flow line[1]	Length		Depth[2]		Width	
	Gallons	*Gallons*	*Ft.*	*in.*	*Ft.*	*in.*	*Ft.*	*in.*
5	180 to 280	240	4	0	5	0	2	0
10	320 to 480	420	5	0	5	6	2	6
15	520 to 680	620	5	6	6	0	3	0
20	720 to 960	860	6	0	5	5	3	6

[1] One foot below inside top.
[2] Total depth.

Installation for sloping ground.—Where the fall is sufficient to offset the head lost (usually about 2 feet) by use of a siphon, a two-chamber tank (as shown in the accompanying diagram) located 50 to 100 feet from the house is preferable. The dimensions of the settling chamber are shown in the table for one-chamber tanks. The capacity of the siphon chamber below the discharge line is about half that of the settling chamber below the flow line. About twice a day the sewage which collects in the

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siphon chamber is ejected quickly by a simple, automatic, cast-iron siphon; thus, sewage is wasted in doses permitting even distribution over a large area and giving time for one flush to work off in the soil and for air to enter the soil before another is received. The distribution area should have about 500 square feet per person and have about 50 feet of 3 or 4 inch tile per person. The distribution tile are generally placed in parallel runs about 10 feet apart, but in uneven ground the runs will be irregular and follow approximately the contour of the land.

Disinfection and Sterilization

Disinfectants most commonly used by the farmer include the following: Formaldehyde (40 per cent solution), lime, compound solution of cresol, chlorinated lime (bleaching powder), saponified cresol solution, mercuric chloride (corrosive sublimate), coal-tar oil emulsions, and sodium hypochlorite solution.

Most of these materials can be readily obtained on the market, and directions for their use are given on the labels. Many of them can not be prepared at home. However, certain of them may be prepared, but this is advisable only when a satisfactory product can not readily be obtained.

The formula for compound solution of cresol is:

Cresol	grams	500
Linseed oil	do	300
Potassium hydroxide (or sodium hydroxide, 54 grams)	grams	80
Alcohol	cubic centimeters	30
Water to make	grams	1,000

The linseed oil is heated to 158° F. with the alcohol and a solution of the sodium or potassium hydroxide to make soap, and the cresol mixed with the soap while still hot.

Saponified cresol solution may be made by any one of several variations of the method of making compound solution of cresol.

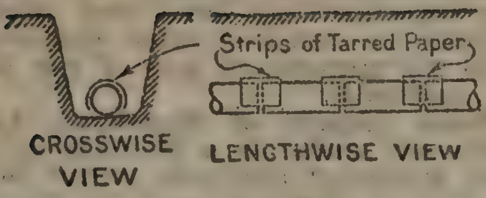
Coal-tar emulsions are made by dissolving rosin in coal-tar oils and adding sodium hydroxide solution to the mixture. When the product so prepared is poured into water a milklike emulsion is formed. The proportions of materials to use depend upon the properties of the particular oil used.

Sodium hypochlorite solution, which deteriorates more or less rapidly on standing, may be prepared by the following formula:

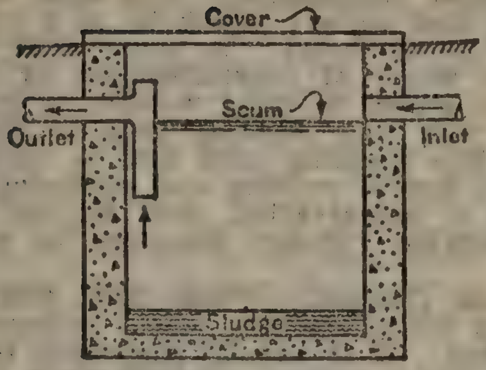
Sodium carbonate monohydrate	grams	70
Chlorinated lime (bleaching powder)	do	100
Water to make	do	1,000

The bleaching powder is leached with water, the soda solution dissolved and added to the solution so obtained, and the mixture filtered. This is what is known as Labarraque's solution and is used as a bleaching agent as well as a disinfectant. Its action as a disinfectant is readily destroyed by organic matter, and its use as such is applicable only in the practical absence of organic matter, or where the organic matter has been first removed by cleaning with soap and water.

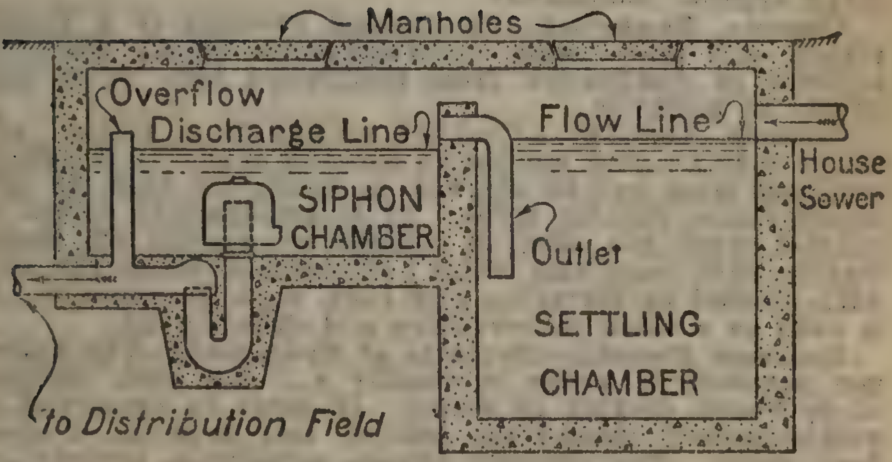
For many purposes about the farm or household fresh hydrated lime or quicklime (not "air-slaked" or carbonated lime), or a water suspension of freshly slaked lime



Distribution tile: Method of protecting open joint



One-chamber septic tank



Two-chamber septic tank

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(milk of lime), is one of the best disinfectants, and also a good deodorant.

For the disinfection of dishes, bed linen, clothing, and sick-room utensils that have been used by patients having infectious or communicable diseases, boiling in water for 5 to 10 minutes is one of the best and most easily applied methods.

Ammonia Water (Spirits of Hartshorn, Ammonium Hydroxide).—Ammonia water is a solution of ammonia gas in water. The strongest ammonia water in use contains about 27 per cent of the gas, and the ammonia in common use is about half this strength or less. It has a well-known, pungent odor, is a strong alkali, and is extremely irritating to the eyes, nose, and skin. On this account it is very dangerous if handled carelessly. It must be preserved in well-stoppered bottles that are kept in a cool place. It is used in washing as an assistant to soap (see washing soda), in medicine, and for neutralizing acids.

Borax (Sodium Tetraborate).—The usual form of borax is the crystallized variety which is, as a rule, in a pure condition. "Burnt borax" is borax that has been deprived of its water of crystallization by being heated. Borax may be stored in tight wooden or iron containers in the same way that washing soda is stored. It is a weak alkali like washing soda and is used as a water softener, as a flux in welding and soldering metals, as a medicine, as a preservative, and in the tanning and ceramic industries. Borax dissolves in water and in glycerine.

Carbolic Acid (Phenol).—When pure, this compound is in the form of white crystals, which however, are usually tinged with red. It is usually dispensed in the form of a liquid. It has a strong, characteristic odor and is a powerful, corrosive poison. If it is accidentally swallowed, whites of several eggs should be swallowed and an emetic taken to cause immediate vomiting. If it gets on the skin, wash it off at once with soap and water followed by alcohol or glycerine, which should in turn be washed away. Carbolic acid is used as an antiseptic in medicine, in dentistry, and for the preparation of many organic compounds.

Creosote, Beechwood.—Beechwood creosote is a faintly yellow, oily liquid with a characteristic smoky odor. It is made by distillation from beechwood tar. It is used chiefly in medicine.

Creosote, Coal-Tar.—Coal-tar crosote is a yellow, oily liquid with an odor similar to carbolic acid. It is poisonous and must not be allowed to touch the skin, as this would cause painful sores. If it accidentally comes in contact with the skin, it should be washed off immediately with soap and water; if possible, bathe the spot with alcohol or glycerine and then wash thoroughly. It is used as a wood preservative and disinfectant.

Hydrogen Peroxide (Peroxide of Hydrogen).—The hydrogen peroxide in trade is usually a 3 per cent solution of hydrogen dioxide in water. It must be preserved in well-stoppered, dark-glass bottles and kept in a cool, dark place. The cheaper grades sometimes contain an excess of sulphuric acid. It is used as an antiseptic mouth wash and gargle, but should be diluted at least one-half with water when applied in this way. When applied to a wound or sore place it foams profusely. Hydrogen peroxide is also used for bleaching straw and as an oxidizing agent.

Chloride of Lime (Bleaching Powder, Calcium Hypochlorite).—This chemical is made by the exposure of slaked lime to chlorine gas in tight chambers; hence it is some-

times called "chlorinated lime." It is not the same as chloride of calcium. It is a white powder with a strong odor of chlorine when freshly exposed. On standing in an open container for several days it loses most of the chlorine odor and becomes moist and sticky. The fresh powder contains about 30 per cent of "available chlorine," on which its value and usefulness depend. It is used extensively for bleaching cotton or linen goods, also as a disinfectant and deodorizer. For the two latter purposes apply it by sprinkling the powder with a wooden scoop into drains or cesspools. For some purposes it is best used in the form of a thin, watery paste. Chloride of lime should be stored in air-tight iron or wooden containers and kept in a dry place. As a rule it is best to purchase this chemical in original pound packages, which can be opened when needed.

ANTIDOTE.—In case of poisoning from the fumes, get the patient into fresh air as quickly as possible and send for a doctor.

Potash Lye (Caustic Potash, Potassium Hydroxide).—Potash lye is a white, lumpy solid that takes up moisture rapidly from moist air. It is very similar to soda lye, but it is even more corrosive and its chemical activity is greater. The same rules for storing and handling soda lye apply equally well to potash lye. It must be handled with great caution. When oils or fats are saponified with potash lye, a soft soap is formed. The "potash" alone means potassium carbonate, which is similar to washing soda. Potash lye is used in soap manufacture, in medicine, and as a source of potassium compounds.

Soda Lye (Caustic Soda, Sodium Hydroxide).—Soda lye is a white, lumpy solid that dissolves easily in water, alcohol, or glycerine. It must be stored in tight iron or glass containers, as it loses strength if exposed to the air. Chemically it is one of the strongest alkalis known and exerts a very corrosive action on nearly every material of animal origin. It rapidly destroys wool, leather, hair, and fur. Great care must be taken not to let it touch the skin, as it rapidly develops painful burns. Soda lye is extensively used in the refining of petroleum oil, vegetable oils, in tanning, soap manufacture, the textile industry, medicine, organic preparations, and for making other sodium compounds.

Saltpeter (Niter, Potassium Nitrate).—Saltpeter is a white, crystalline compound. It differs from chili saltpeter, which is the sodium nitrate. It may be stored in any convenient container, but great care must be used not to allow any organic matter, such as sawdust, leaves, charcoal, or other combustible material to be mixed with it, as such a mixture would be liable to explode or burn with great violence if ignited. It is one of the principal constituents of gunpowder, the other two being charcoal and sulphur. It is used in the pickling of meats, in medicine, and in the manufacture of gunpowder, pyrotechnics, fertilizers, and tobacco.

Washing Soda (Soda Crystals, Sal Soda, Sodium Carbonate Crystals).—Washing soda consists of large, clear crystals which lose some of their crystal water on exposure to dry air and become coated with a white powder. This operation does not affect the quality of the soda. Washing soda is readily soluble in water, and when used in "hard waters" that contain lime or magnesia, it causes these substances to precipitate as white powders. Soda is accordingly often used as a water softener and it is this property that makes it a valuable assistant in washing; it makes the water soft and prevents wastage of soap. The storage of all kinds of soda offers no difficulties. Any clean wooden container will suffice, but washing soda

must be kept in tight boxes if it is desired to keep the crystals in a clear condition. Soda is used in washing, wool scouring, soap making, glass manufacture, dyeing, bleaching, water softening, paper making, photography, and in medicine.

Sanitation of Farm Water Supply

Diseases Conveyed by Polluted Water.—Typhoid fever, cholera, and probably diarrheal diseases, such as dysentery or cholera infantum.

Appearance Not an Indication of Purity.—A clear, sparkling, tasteless water may be polluted. A yellow or dark-brown water, a muddy water, or a water with a cucumber or fishy odor may be harmless.

Dangerous Pollution.—Excreta from warm-blooded animals.

Indications of Pollution.—Prescence of bacteria of the colon group. High, free ammonia, nitrite, etc. Laboratory test is required to obtain proof of pollution.

Obvious Sources of Pollution.—Access of surface water to source of supply through faulty walls, casings, platforms, faults and cracks in rock; dust and dirt on bucket and rope; near-by cesspools; broken sewage lines; surface surrounding well overburdened with filth from manure heaps, outhouses, stables, and pigpens; dust blowing into uncovered well or spring.

Correction of Unsanitary Conditions.—Trace out and remove cause of pollution, or abandon the source of supply.

Analysis.—The question of analysis should be taken up with State officials and not with the Federal Government.

Emergency Treatment of Suspected Water.—(1) Boil the water for 20 minutes in a wash boiler or other suitable container. (2) Prepare a chloride-of-lime solution by dissolving 1 teaspoonful fresh chloride of lime (bleaching powder) in 1 quart of water. Place this stock solution in a stoppered bottle. Such a solution gradually loses its strength, and fresh solutions should be made up occasionally. For disinfecting water, mix thoroughly 1 teaspoonful of this solution with 2 gallons of water. After 30 minutes the water will usually be fit to drink. (3) Ordinary tincture of iodine contains approximately 7 per cent of iodine. Mix 1 drop of this tincture thoroughly with 1 quart of water. The water so treated will usually be safe for drinking purposes after 30 minutes. Larger quantities of water may be disinfected by the use of proportionate quantities of these chemicals.

Caution.—Ordinarily it is inadvisable for the layman to attempt to purify drinking water by the addition of chemicals. Waters require varying quantities of chemicals to sterilize them, because of their variable content of organic or mineral matter which combines with chlorine and iodine.

4. AGRICULTURAL TECHNOLOGY

.0 General.
.1 Milling.
  .10 General.
  .11 Experimental milling.
    .110 General.
    .111 Sampling.
    .112 Preparation.
    .113 Equipment.
    .114 Operation.
    .119 Miscellaneous.
  .12 Commercial milling.
    .120 General.
    .121 Classification (grains).
    .122 Selection.
    .123 Storage.
    .124 Preparation.
    .125 Equipment.
    .126 Operation.
  .19 Miscellaneous.
.2 Starch and sugars.
  .20 General.
  .21 Starch.
    .210 General.
    .211 Cassava.
    .212 Corn.
    .213 Potato.
    .219 Miscellaneous.
  .22 Sugar.
    .220 General.
    .221 Beet.
    .222 Cane.
    .223 Corn.
    .224 Dextrose and levulose.
    .225 Honey.
    .226 Maple.
    .227 Milk.
    .229 Miscellaneous.
  .23 Sirup.
    .230 General.
    .231 Apple.
    .232 Corn.
    .233 Maple.
    .234 Muscadine grape.
    .235 Sorgo.
    .236 Sugar beet.
    .237 Sugar cane.
    .238 Sweet potato.
    .239 Miscellaneous.
  .29 Miscellaneous.
.3 Fruit juices and vinegars.
  .30 General.
  .31 Fruit juices.
    .310 General.
    .311 Apple.
    .312 Berries.
      .3121 Blackberry.
      .3122 Huckleberry.
      .3123 Strawberry.
      .3124 Raspberry (black).
      .3125 Raspberry (red).
      .3129 Miscellaneous.

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.3 Fruit juices and vinegars—Continued.
.31 Fruit juices—Continued.
.313 Cherry.
.314 Grape.
.315 Lemon.
.316 Orange.
.317 Peach.
.318 Pineapple.
.319 Miscellaneous.
.32 Vinegars.
.320 General.
.321 Apple.
.322 Berry.
.323 Grape.
.324 Honey.
.325 Orange.
.326 Peach.
.327 Persimmon.
.328 Pear.
.329 Miscellaneous.
.3291 Grains.
.3292 Maple products.
.3293 Molasses.
.3294 Watermelon.
.39 Miscellaneous.
.4 Fats and oils.
.40 General.
.41 Vegetable oils.
.410 General.
.411 Castor.
.412 Coconut.
.4121 Edible.
.4122 Inedible.
.413 Corn.
.4131 Edible.
.4132 Inedible.
.414 Cottonseed.
.4141 Crude.
.4142 Refined.
.415 Linseed.
.416 Olive.
.417 Peanut.
.4171 Edible.
.4172 Inedible.
.418 Soy bean.
.4181 Edible.
.4182 Inedible.
.419 Miscellaneous.
.4191 Mustard seed.
.4192 Palm kernel.
.41921 Edible.
.41922 Inedible.
.4193 Palm.
.4194 Peppermint.
.4195 Raisin seed.
.4196 Rapeseed.
.4197 Vegetable stearin.
.42 Animal fats and oils.
.420 General.
.421 Cod and cod-liver oil.
.422 Garbage grease.
.423 Herring oil.
.424 Horse oil.
.425 Lard.
.4251 Edible.
.4252 Inedible.
.4253 Neutral.

.4 Fats and oils—Continued.
.42 Animal fats and oils—Continued.
.426 Oleo stock.
.427 Tallow.
.4271 Edible.
.4272 Inedible.
.428 Wool grease.
.429 Miscellaneous.
.43 Fat and oil derivatives.
.430 General.
.431 Acidulated soap stock.
.432 Cottonseed foots.
.4321 Crude.
.4322 Distilled.
.433 Fatty acids.
.4331 Crude.
.4332 Distilled.
.434 Greases.
.4341 Brown.
.4342 Curriers.
.4343 Sewer.
.4344 Tankage.
.4345 White.
.4346 Yellow.
.4349 Miscellaneous.
.435 Lard.
.4351 Oil.
.4352 Stearin.
.436 Oleo oil.
.4361 Edible.
.4362 Inedible.
.437 Tallow and oleo stearin.
.4371 Edible.
.4372 Inedible.
.438 Tallow oil.
.439 Miscellaneous.
.4391 Red oil.
.4392 Stearic acid.
.49 Miscellaneous.
.5 Dyes and tanning.
.50 General.
.51 Dyeing.
.510 General.
.511 Theory.
.512 Vegetable fibers.
.5121 Cotton.
.5122 Linen.
.5123 Hemp.
.5124 Jute.
.5125 China grass.
.5129 Miscellaneous.
.513 Animal fibers.
.5131 Wool.
.5132 Silk.
.5133 Wild silk.
.5139 Miscellaneous.
.514 Artificial fibers.
.5141 Artificial silk.
.5149 Miscellaneous.
.515 Special colors (effects, shades, not dyes).
.516 Dyeing special articles.
.517 Garment dyeing and cleaning.
.518 Home dyeing.
.5181 Equipment.
.51811 Dye pots.
.51812 Heating devices.
.51813 Stirring rods or dye sticks.

.5 Dyes and tanning—Continued.
.51 Dyeing—Continued.
.518 Home dyeing—Continued.
.5181 Equipment—Continued.
.51814 Wringers.
.51815 Drying arrangements.
.51819 Miscellaneous.
.5182 Celluloid.
.5183 Easter eggs.
.5184 Feathers.
.5185 Gloves.
.5186 Hats.
.5187 Textiles.
.5189 Miscellaneous.
.519 Miscellaneous.
.52 Washing and bleaching.
.520 General.
.521 Cotton.
.522 Linen.
.523 Hemp.
.524 Jute.
.525 Wool.
.526 Silk.
.527 Tussah silk.
.529 Miscellaneous.
.53 Dyes and dyestuffs.
.530 General.
.531 Artificial dyestuffs (coal-tar colors).
.5311 Direct cotton or salt colors.
.5312 Sulphur colors.
.5313 Basic colors.
.5314 Eosins and rhodamines.
.5315 Acid colors.
.5116 Mordant colors (alizarins and others).
.5317 Acid chrome colors.
.5318 Compounds of aromatic series (phenol dyes).
.5319 Miscellaneous colors.
.53191 Aniline black.
.53192 Indigo or vat colors.
.53193 Insoluble azo colors.
.532 Natural dyestuffs.
.5321 Indigo.
.5322 Logwood.
.5323 Fustic.
.5324 Cutch or catechu and gambier.
.5325 Safflower, annatto.
.5326 Red woods.
.5327 Madder.
.5328 Cochineal, kermes, and lac dye.
.5329 Miscellaneous.
.53291 Quercitron bark and flavin.
.53292 Weld.
.53293 Turmeric.
.53294 Persian berries.
.53295 Young fustic.
.53296 Archil and cudbear.
.533 Mineral dyes.
.5331 Chrome yellow.
.5332 Chrome orange.
.5333 Chrome green.
.5334 Manganese brown.
.5335 Iron buff and Nanking yellow.
.5336 Khaki.
.5337 Prussian blue.
.5339 Miscellaneous.
.539 Miscellaneous.

.5 Dyes and tanning—Continued.
.54 Mordants.
.540 General.
.541 Acids and acid mordants.
.5411 Inorganic.
.5412 Organic.
.5413 Oil mordants (fatty acids, turkey red oil).
.5414 Tannins and allied compounds.
.5419 Miscellaneous.
.542 Bases and salts, and basic mordants.
.5421 Potassium compounds.
.5422 Sodium compounds and soap.
.5423 Ammonium compounds.
.5424 Calcium compounds.
.5425 Barium compounds.
.5426 Magnesium compounds.
.5427 Aluminum compounds.
.5428 Chromium compounds.
.5429 Miscellaneous.
.54291 Iron compounds.
.54292 Tin compounds.
.54293 Titanium compounds.
.54294 Copper compounds.
.54295 Lead compounds.
.54296 Manganese and antimony compounds.
.54297 Zinc and nickel compounds.
.54298 Cobalt, vanadium, serium, tungsten, uranium.
.54299 Various chemicals.
.549 Miscellaneous.
.55 Tanning.
.550 General.
.551 Classification.
.5511 Hides proper.
.5512 Kips.
.5513 Skins.
.5519 Miscellaneous.
.552 Skinning, curing, storing.
.553 Equipment and tools.
.554 Methods.
.5541 Oil tanning.
.5542 Mineral tanning.
.55421 Alum.
.55422 Chrome.
.5543 Vegetable or bark tanning.
.55431 Oak bark.
.55432 Hemlock bark.
.55433 Gall nuts.
.55434 Sumac.
.55435 Catechu or cutch.
.55436 Gambier.
.5544 Combination tanning.
.5549 Miscellaneous.
.555 Tanning process.
.5551 Preliminary operations.
.55511 Slaking lime.
.55512 Soaking and cleaning.
.55513 Liming.
.55514 Unhairing.
.55515 Fleshing.
.55519 Miscellaneous.
.5552 Bark-tanned sole and harness leather.
.55521 Deliming.
.55522 Tanning.
.55523 Oiling and finishing.
.55529 Miscellaneous.

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.5 Dyes and tanning—Continued.
.55 Tanning—Continued.
.555 Tanning process—Continued.
.5553 Chrome-tanned leather.
.55531 Deliming.
.55532 Tanning.
.55533 Washing and neutralizing.
.55534 Oiling and finishing.
.55539 Miscellaneous.
.5554 Alum-tanned lace leather.
.55541 Deliming.
.55542 Tanning.
.55543 Oiling and finishing.
.55549 Miscellaneous.
.5555 Tanning fur skins.
.55551 Soaking and fleshing.
.55552 Combination tannage.
.55553 Salt-alum tannage.
.55554 Salt-acid tannage.
.55559 Miscellaneous.
.556 Leather dyeing and staining.
.557 Care of leather.
.5571 Boots and shoes.
.5572 Harness.
.5573 Driving belt.
.5574 Bookbinding leather.
.5575 Traveling bag and suit case.
.5576 Purse, pocketbook, wallet.
.5577 Furniture upholstered in leather.
.5578 Mildewing of leather.
.5579 Miscellaneous.
.559 Miscellaneous.
.59 Miscellaneous.
.9 Miscellaneous.
.99 Classification of literature on agricultural technology.

AGRICULTURAL TECHNOLOGY

MILLING

Experimental Milling

General.—Value of wheat is almost entirely dependent upon its milling and baking quality, which can be determined accurately only through actual milling and baking tests. Such tests are necessary for determining the essential factors in the fixing of equitable standards.

Classification.—There are five classes of wheat which take into account botanical differences, including color, texture, habit, and difference in use.

(1) The hard red spring class is composed of the common red wheats of spring habit and is well adapted to the manufacture of bread flours.

(2) The durum class is composed of all durum wheats and is used principally for semolina for the manufacture of macaroni and other alimentary pastes.

(3) The hard red winter class is composed of the hard red varieties of common wheats of winter habit and is used primarily for the production of bread flours.

(4) The soft red winter class is composed of the soft red varieties of common wheats of winter habit and the red club wheats and is best adapted to the production of flour for pastry, hot biscuits, and crackers. Some wheats of this class also produce a very satisfactory bread flour.

(5) The white class is composed of the common white varieties and the white club wheats. With the exception of the white club varieties, which produce a granular, creamy flour, this class is adapted to the same uses as the soft red winter class, and in addition, on account of its color, is used extensively for the manufacture of those breakfast foods in which the whole kernel is utilized.

Sampling.—Each sample for a milling test is given a number, and the size of the sample usually ranges from 4 to 8 pounds. The mechanical analysis consists of an examination for odor, temperature, and the presence of live insects. The analysis for other grading factors consists of dockage, test weight per bushel, moisture, damaged kernels, foreign material other than dockage, smut, kernel texture, and wheats of other classes. The milling and baking quality of wheat is not dependent upon any one factor but upon a combination of factors, both physical and chemical.

Preparation for Milling.—The various operations in the preparation of the sample for milling are as follows: (1) Determining the test weight per bushel of the wheat received; (2) cleaning the grain and running it through a milling separator to remove the foreign material present; (3) weighing the clean grain; (4) determining the test weight per bushel for cleaned grain; (5) scouring the grain in a wheat scourer; (6) weighing the scoured grain; (7) determining the test weight per bushel of the scoured grain; (8) determining the moisture content of the grain; and (9) tempering the sample. This process consists in the addition of sufficient water to the wheat to raise its moisture content to the percentage desired. Moisture content considered desirable for the milling of soft wheats is 14 per cent and of hard wheats 15 per cent.

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Equipment.—The experimental mill used by the Department of Agriculture consists of two units or mills. Each unit consists of four stands of 6 by 6 inch rolls and one box sifter. Three pairs of rolls of each unit are corrugated and one is smooth. Each unit is driven by a 5-horsepower motor of 1,150 revolutions per minute speed. The two sifters, which are mounted together, are driven by a 1-horsepower, slow-speed motor. The milling equipment also includes a humidifier, by means of which the relative humidity of the atmosphere within the mill is maintained at not less than 55 per cent.

Milling Operation.—The operation of milling grain is as follows: (1) Breaking down the grain by means of rollers; (2) sifting the broken-down grain; (3) collecting the products—bran, shorts, and flour.

Milling and Baking Tests.—Experiments covering a long period of years have been conducted by the United States Department of Agriculture in order to aid in improving the quality of the wheat grown. Careful tests have been made to determine the comparative value of varieties within each class and the relative rank of the varieties in the principal quality factors considered in commercial milling and baking.

Average results of milling and baking data, 1915 to 1921, inclusive

Descriptive data	Hard red spring wheat	Durum wheat	Hard red winter wheat	Soft red winter wheat	White wheat
Samples........number..	1,310	432	728	457	580
Test weight per bushel ....pounds..	56.9	59.3	58.8	58.6	58.5
Crude protein.per cent..	13.6	14.9	12.6	11.3	12.0
Straight flour......do....	69.3	70.6	72.0	71.1	70.7
Shorts..............do....	15.3	17.6	13.1	13.5	14.8
Bran................do....	15.4	11.6	14.9	15.4	14.5
Water absorption of flour. ....per cent..	59.4	62.0	60.0	55.9	56.8
Loaf volume............. ....cubic centimeters..	2,142	1,945	2,121	2,001	1,872
Loaf weight.......grams..	493	507	497	489	484
Loaf texture.......score..	89.5	89.7	90.3	88.9	87.2
Loaf color..........do....	89.3	88.1	90.4	89.1	90.2
Ash in flour....per cent..	.50	.77	.46	.46	.46

Conclusions

(1) New varieties of wheat must not only yield more but must be of sufficiently good quality to result in a higher acre return in order to replace the old varieties on the farm.

(2) Wide variations in the principal milling and baking factors occur within a variety of wheat due to the season and locality in which the crop is grown. Results on less than five samples of a variety of wheat are not a reliable indication of its milling and baking value.

(3) Marquis is the best variety of hard, red spring wheat in milling and baking quality. It also is the most productive variety except in northwestern North Dakota and northeastern Montana, where it is slightly out-

yielded by Red Fife, and during the frequent seasons in which rust occurs in North Dakota and South Dakota when it is outyielded by the Kota variety. With the above exceptions Marquis should replace all other varieties of hard, red spring wheat in the northern spring-wheat regions. Prelude, Pioneer, Ruby, and Kota are only slightly inferior to Marquis in quality and only slightly superior to Kitchener, Red Fife, Glyndon, Haynes Bluestem, Power, and Preston.

(4) Kubanka excels all other varieties of durum wheat in baking quality, followed by Kubanka No. 8, Kubanka No. 98 (Nodak), Arnautka, and Peliss. Pentad, Buford, and Mindum are of poor baking quality. Baking quality, however, is not necessarily a measure of the macaroni value of durum wheats. Kubanka is the most generally adapted variety of durum wheat in North Dakota and South Dakota, but during seasons of severe rust it is considerably outyielded by Acme and Monad. In Minnesota, Mindum is more productive than Kubanka, whereas in Montana, Wyoming, and Colorado Peliss is the most productive durum wheat.

(5) The three leading varieties of hard red winter wheat—Turkey, Kharkof, and Kanred—are practically equal in milling and baking value. All the varieties of hard red winter wheat are satisfactory for milling and bread making, although Blackhull, Minturki, and Alton are softer wheats and in some respects inferior to the others.

(6) Kanred is the most productive wheat in the central hard red winter-wheat region, but outside of this region Turkey and Kharkof, or selections from them, yield about as well. Minturki is the highest yielding winter wheat in Minnesota. Blackhull yields nearly as well as Kanred in central Kansas.

(7) The Red Rock variety has the highest bread-making qualities of the soft red winter wheats. Other good varieties are Purplestraw, Minhardi, Odessa, Fulcaster, Fultz, and Buffum No. 17. The poorest varieties in quality are Red Russian, Red Wave, Jones Fife, and Hybrid 123.

(8) Bobs, Hard Federation, White Federation, Federation, and Galgalos are among the best of the white wheats for bread making. Baart, Dicklow, and Pacific Bluestem are of good milling and baking quality, whereas Goldcoin and the club wheats, Hybrid 128 and Little Club, are low in bread-making qualities.

(9) Baart is the most productive spring wheat in the dry sections of Washington and is well adapted to Arizona, central and eastern Oregon, and drier sections of California. Hard Federation outyields Baart on the dry lands in Oregon. Federation and Dicklow are the most productive wheats on the irrigated lands in Idaho and Oregon. Hybrid 128, a winter variety of club wheat, is the most productive wheat in the subhumid sections of southeastern Washington and northeastern Oregon.

(10) Comparison of the milling and baking qualities of the various classes of wheat shows hard red spring wheat to have averaged lowest in test weight per bushel of dockage-free wheat, and in yield of "straight" flour, and highest in volume of loaf, while in yield of bran it was one of the two classes showing the highest percentages. It also averaged high in protein content and yield of shorts.

(11) Durum wheat showed the highest average results in test weight per bushel of dockage-free wheat, protein content, yield of shorts, water absorption of flour, weight of loaf, and ash content of flour. This class averaged

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lowest in yield of bran and in color score of bread, and was low in yield of flour.

(12) Hard red winter wheat averaged highest in yield of flour and in color and texture of bread, and second highest in test weights per bushel, yield of bran, water absorption of flour, and weight of loaf. It averaged lowest in yield of shorts.

(13) Soft red winter wheat was one of the two classes averaging highest in yield of bran. It averaged second highest in yield of flour. It averaged lowest in crude protein of wheat and in water absorption of flour, and second lowest in yield of shorts, and in weight, color, and texture of loaf. It was one of the three classes averaging lowest in ash content of flour.

(14) White wheat did not excel in any factor. Its best points were its high color score and low ash content of flour. It averaged lowest in volume, weight, and texture of loaf, and second lowest in test weight per bushel and crude protein content of wheat, and in water absorption of flour.

STARCH AND SUGARS

Starch

Cassava Starch.—Cassava grows in this country in the peninsula of Florida and in a comparatively narrow belt along the Gulf coast. The general course of procedure in the making of starch from cassava is the same as with potatoes. Pulp the roots in a pulping machine, and separate the starch by washing through a sieve or bolting cloth. Allow the starch to settle, draw off the top liquor, add more water, stir, and again allow the starch to settle. Repeat this operation until the starch is sufficiently light in color. The starch is then dried. The yield of high-grade air-dry starch amounts to 20 to 25 per cent of the weight of the fresh roots. Cassava will yield nearly double the percentage of starch obtained from potatoes.

Cornstarch.—Among the products of corn is cornstarch, which is used in the preparation of a large number of human foods. Marketable cornstarch was first produced in 1842, and it is now manufactured on a large scale in the Middle West and in the East. Starch products from corn include cornstarch (for table use), pearl starch, gloss starch, laundry starch, dextrin (used in making pastes and adhesives), corn sugar (various grades), and commercial glucose or corn sirup.

Potato Starch.—The manufacture of starch from potatoes in this country is confined principally to the States of Maine, Wisconsin, and Minnesota. Practically all of the domestic production is used in the textile industry where it is superior to cornstarch for certain purposes. The process of manufacture is simple. The following description of a procedure followed in a starch factory in Aroostook County, Me., is typical.

After being weighed, the potatoes are conveyed to a revolving washer about 12 feet in length and from 18 to 24 inches in diameter. A stream of water flowing in a direction opposite to that of the motion of the potatoes accomplishes the final washing with clean water. The rasping machine consists of a cylinder about 30 inches in diameter and 36 inches long. The rasping cylinder revolves as near a brace of hardwood as can be, and the potatoes, being stopped by the brace from passing, are reduced to a fine pulp by the rapidly revolving drum. A stream of water is thrown upon the potatoes as they enter the pulping machine, so that the pulp is readily washed through as it is reduced to the required degree of fineness. The pulp falls from the rasper onto a starch separator, the bottom of which consists of wire gauze having 30 meshes to the inch. This separator is slightly inclined, so that the shaking process gradually moves the pulp toward the lower end. During the progress of the pulp along the separator, jets of water are thrown upon it from pipes arranged above. The water detaches the starch granules from the pulp, and the granules being small enough to pass through the meshes of the screen are carried through, while the pulp is left upon the screen, to be ejected finally at the lower end. The starch, which is carried through by the water, is conveyed to large settling tanks.

After the starch has settled, the water is drained off, and the crude starch is lifted by shovels and thrown into

another tank of somewhat smaller size fitted with a revolving stirrer. Water is added at the same time, and the starch is beaten into a cream and again allowed to settle. This process is simply for washing the starch and removing the larger portion of impurities. In the second settling the pure white starch first goes to the bottom, and when the water is drawn off it is found to be covered with a thin layer of starch mixed with various impurities. This layer is removed separately, and the pure starch underneath is then ready for drying. The layer of dirty starch is subjected to one or more washings and settlings for the recovery of as much white starch as practicable. The white starch is dried on tiers of racks in a kiln heated either by steam coils or by furnace pipes. The large blocks of wet starch are placed on the top racks and after a few hours' drying readily crumble when raked and fall through the slats of the racks to the racks below. The starch becomes drier and drier as it is brought in contact with the hot air and, upon being raked, crumbles into smaller particles and continues to descend through the slats of the tier of racks until it reaches the bottom. The dried starch is finally raked off into a trough alongside of the kiln, and after being mixed to equalize moisture content is placed in barrels for shipping. Since starch factories usually purchase only cull and damaged potatoes, the starch content is naturally low, the average yield being 6 to 7 pounds of starch per bushel of potatoes.

For making potato starch in the home the only equipment needed is two clean galvanized tubs, a large dish pan, one cylindrical grater, plenty of water, and wiping cloths. Take 5 bushels of potato culls and wash them thoroughly by the use of water and a small scrubbing brush. Use one tub for cleaning potatoes and the other for the gratings. Seat yourself in a convenient place between the two tubs, with dish pan and grater in your lap. Without removing the skin, grate the clean potatoes from the right-hand tub in the dish pan, and empty the pan of gratings when necessary into the well-cleaned tub to your left. Continue this operation until the left-hand tub is a trifle more than half full. Pour clean water into the tub upon the potato gratings until it is nearly full, and stir well so as to saturate every particle with water. Remove all peelings and floating material from the surface of the water.

Allow the tub to stand over night, so that the starch will settle to the bottom and all potato skins will rise to the surface of the water. In the morning, remove the water carefully from the tub, as well as the dark formation and sediment on top of the layer of starch. Pour a fresh supply of water over the starch again, so as to rinse well all particles of starch, and allow to stand for eight hours. Again remove the water and also any dark layer of sediment on top of the starch, and in doing so be careful not to waste the starch. Continue this process, making new applications of water, and stirring as many times as are necessary to effect a satisfactory separation of starch from the skins and dark portions of the potatoes. Four or five washings are ordinarily required. Remove the starch, and dry thoroughly.

Potato starch is a nutritious food and can be used to advantage for making puddings, salads, and milk dishes. The potato water and wastes incident to the process can be easily utilized on the farm for feeding hogs and poultry. White starch of good quality, but with reduced yield, may be obtained from frosted and slightly decayed potatoes.

Sugar

Beet Sugar.—The manufacture of beet sugar requires expensive machinery, large investment of capital, and highly technical chemical control. It is not practicable on a small scale. The following steps are involved in the process of manufacture: (1) Storing the beets, (2) cleaning and slicing the beets, (3) extraction of the juice by diffusion, (4) purification of the juice with lime and other chemicals, (5) evaporation in multiple effects under diminished pressure, (6) formation of the grain in a specially constructed vacuum pan, (7) separation of the sugar crystals from the molasses by centrifugal force, (8) drying the sugar, and (9) packing for market.

Cane Sugar.—Sugar is removed from cane by the process of crushing the stalks and pressing out the juice between heavy rollers. After the cane is weighed it passes along conveyors to a powerful crusher, which breaks the stalks and squeezes out a part of the juice. The cane mat is then passed between several three-roller mills, which press out practically all the juice still remaining in it. The bagasse, or woody part of the cane, which has been pressed dry, is either conveyed to the boiler house to be used for fuel or sold for the manufacture of fiber board and insulating lumber. The juice, after being screened for removal of the coarser solids held in suspension, goes to the clarifiers or purification tanks, then to the multiple evaporators, and finally to the crystallizing vacuum pan, where it is boiled to grain or made into sugar. The molasses, which is also a product of the boiling process, is separated from the sugar crystals by centrifugal force. Most of the cane sugar produced directly from the cane, as above outlined, is called raw sugar. Refineries receive the raw sugar and convert it into the refined cane sugar of commerce by use of a somewhat different process. Cane-sugar manufacture requires expensive machinery and large investment of capital. It is not practicable on a small scale.

Corn Sugar.—This is also known as "commercial dextrose." (See Dextrose and levulose.)

Dextrose and Levulose.—Besides cane and beet sugar, the commonest kinds of sugar are dextrose, or grape sugar, which is less sweet, and levulose, which is somewhat sweeter than ordinary sugar. These two sugars usually occur together in nature, and are consumed in the eating of various fruits, honey, and sirups. Refined dextrose, or corn sugar (made from starch), is now manufactured on a large scale commercially. It is not practicable, however, to make either dextrose or levulose on a small scale in the home.

Honey.—Before sugar was a common commercial product, honey stored by the honeybee was generally used to sweeten foods. Honey varies somewhat in composition, a typical analysis showing 74.52 per cent of invert sugar, 1.90 per cent of sucrose, 17.59 per cent of water, and 0.18 per cent of mineral matter. Its flavor is due to volatile substances in the flowers from which it is obtained, some flowers imparting a more agreeable flavor than others to the honey. Its behavior in cooking is different from that of the ordinary sugars.

Maple Sugar.—When a small quantity of maple sugar is manufactured, in addition to the sirup, the ordinary iron pot of the kitchen may be used and the sirup concentrated over the kitchen fire. On a larger scale, however, the sugaring-off pan is used. A small piece of butter, lard, some sweet oil, or a piece of fat meat, such as

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bacon or fresh pork, may be run over the surface to stop the foaming which occurs when the sirup is boiled. If the sediment is heavy, white of egg or milk may be added and skimmed off during the boiling. Under all circumstances the boiling mass should be skimmed.

The proper point for stopping the boiling is best determined by means of a thermometer. Another means is to drop some of the liquid in cold water or on snow. Boiling should be carried up to 238° or 240° F. during the first run of sap. With later runs the finishing temperature should be 240° to 250° F. After the thick sirup has reached the proper boiling point it should be taken from the fire and stirred until somewhat cooled. This gives it a uniform grain and color in the mold. Large cakes of maple sugar are usually formed in wooden molds, but the smaller cakes are formed in tin molds. The mold should be dry and warm. After being taken out it can be wrapped in paper, but should not be placed in covered containers unless they are completely sealed. It is best to store the sugar in a warm room of even temperature.

Milk Sugar.—Milk contains from 4 to 5 per cent of milk sugar or lactose. When manufactured by a commercial process lactose is a crystalline product, resembling other sugars in appearance. It is often found in prepared foods, especially those made for invalids and children. It is much less sweet than cane sugar.

Sirup

Apple Sirup.—The method of making apple sirup on the farm is simple, and the farm housewife who is provided with a large preserving kettle can readily make a few quarts of the product in her own kitchen. The method is as follows:

(1) To make 1 gallon, stir into 7 gallons of apple cider 5 ounces of powdered calcium carbonate (carbonate of lime).

(2) Heat the cider and allow it to boil for a few minutes. After boiling it, pour the cider into vessels, preferably tall glass pitchers or preserving jars, and let the liquid settle over night.

(3) After the liquid is perfectly clear and shows a distinct sediment at the bottom, pour off the clear portion into the preserving kettle, being careful not to pour off any of the sediment. Add to the clear liquid a level teaspoonful of carbonate of lime and again stir thoroughly. Complete the process by boiling down the clear liquid rapidly.

(4) Use a candy thermometer, and allow the liquid to boil until it reaches 220° F. When there is no thermometer at hand, boil the liquid until it reaches about one-seventh of the original volume, or until a small portion, when cooled rapidly and poured from a spoon, shows the same consistency as maple sirup.

(5) Pour off the liquid into the pitchers or fruit jars and let it stand where it will cool very slowly. When the sirup has cooled there will be found a white sediment which is harmless. When the settling has been completed, carefully pour off the clear portion of the sirup into a kettle, heat nearly to boiling, pour into sterilized jars, and seal them at once, as in preserving.

The product will be clear and ruby colored, varying from a deep ruby red to lighter shades, according to the character of the windfall apples used in making the cider. The sirup can be used like any other table sirup.

Corn Sirup.—In the making of corn sirup, otherwise known as commercial glucose, raw (corn) starch is mixed

with water to form what is known as starch milk, a small quantity of hydrochloric (muriatic) acid is added, and steam is applied under pressure in large closed "converters." The product is run into a tank where alkali is added to neutralize the acid used, and the liquid is then filtered and decolorized in much the same way as cane sugar is purified. It is finally evaporated to the proper consistency in vacuum pans. Commercial glucose has but little flavor and is less sweet than cane sirup. It is commonly mixed with cane sirup, or sorgo sirup, and placed on the market in small containers for use as table sirup. Corn sirup is also used in confectionary manufacture, in baking, and in the manufacture of jams, vinegar, and various other food products. Its manufacture is not practicable on a small scale in the home.

Maple Sirup.—The production of maple sirup is purely an American industry, the United States and Canada being the only countries where this product is made. Following is an outline of the process for concentrating maple sap to sirup: When the sap is heated to boiling in an evaporator, a scum forms, which should be carefully skimmed off during the evaporation by means of a metal skimmer. To make the best quality sirup, evaporation must be as rapid as possible. Shallow pans or evaporators are preferable to kettles for the evaporation. A light-colored, well-flavored sirup will not be obtained by adding fresh sap to partially evaporated sirup in a kettle and only "siruping off" once or twice during the day. This procedure of concentrating, then diluting with fresh sap, and then concentrating again causes decomposition of the sugar and other organic matter and gives the sirup a dark color and strong flavor. To produce the best-flavored and lightest-colored sirup the liquid should not be deeper than 1 to 1½ inches in the evaporating pan at any one time.

According to the regulations of the Federal food and drugs act, maple sirup contains not less than 65 per cent total solids and weighs not less than 11 pounds to the United States gallon. The maker determines the density of his own product. This is often accomplished in a crude way by noting the bubbles as they break on the surface of the boiling sirup or by removing some in a spoon and watching how it pours. A more satisfactory method is to use a thermometer to determine the boiling point or a Baumé hydrometer to measure the density. When evaporation has been completed, the hot sirup is easily filtered through a felt strainer shaped like a cap, 10 inches in diameter at the top and 14 inches deep, or through a double thickness of heavy flannel suspended in the neck of a large milk can, or the sediment may be removed by settling. The sirup is ready for canning after settling or being strained, although care should be exercised to fill the cans or other containers while the sirup is at the proper canning temperature.

Muscadine-Grape Sirup.—The muscadine grape is a native of the southeastern United States, where the vines grow wild in the woods and produce fruit abundantly. Selected choice varieties are grown in vineyards ranging from a quarter of an acre to as many as 200 acres. The sirup made from these grapes has a delicate and unique fruity flavor. It can be used like other table sirups and is excellent with pancakes, waffles, or bread and butter. A bushel of grapes will yield from 2¼ to 4 gallons of fresh juice. The juice is condensed to one-ninth of its original volume to make a sirup of satisfactory consistency, 1 bushel yielding approximately 1⅛ quarts of sirup. The process of making sirup consists of the fol-

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lowing steps: (1) Harvesting the fruit and extracting the juice, (2) boiling with calcium carbonate to reduce the acidity, (3) clarifying the juice, (4) boiling down the clarified juice to a sirup of the desired density, and (5) canning or bottling the sirup.

Sorgo Sirup.—Sorgo is more widely distributed than sugar cane or sugar beets. Although the manufacture of sugar from sorgo is not profitable on either a small or a large scale, sirup making is a comparatively simple process and does not call for expensive machinery or dangerous chemicals. Sorgo sirup is often incorrectly termed "sorghum molasses," and until recently the sirup was generally known as sorghum sirup. The following steps are taken in making the sirup:

(1) Extracting the juice: The ordinary method of obtaining juice from sorgo is by milling—that is, running the stalks between the rollers of a mill.

(2) Settling the juice: The raw juice coming from the mills should be strained and passed into settling tanks that are provided with some arrangement for drawing off the clear juice without disturbing the settlings.

(3) Clarifying the juice: The purpose of clarification is to remove a certain proportion of the objectionable nonsugar substances from the raw juice, so that a better grade of sirup may be obtained. The juice may be clarified by one of the following agencies: (*a*) Heat, (*b*) lime and heat, (*c*) lime and phosphoric acid, or phosphates, and heat, and (*d*) lime carbonate (whiting) and heat. The first process is the simplest and is ordinarily preferred in manufacturing on a small scale.

(4) Evaporation or concentration: The object of the process of evaporation is to remove the water from the raw juice and thereby thicken it to sirup. Evaporation in the production of sorgo sirup is accomplished by (*a*) kettles, (*b*) pans or evaporators heated directly by a furnace, and (*c*) by steam evaporators. During the evaporation the juice and thin sirup are carefully skimmed.

(5) Determining the finishing point: Upon cooling, the finished sirup should have a moisture content of not over 30 per cent, or a solids content of not less than 70 per cent. One gallon of such sirup should weigh not less than 11¼ pounds. The boiling temperature at which sirup is ready to be run out of the evaporator is 224° F. or slightly higher (this is at sea level; for about every 500 feet above sea level the boiling point is lowered 1° F.). Sirup that gives a Baumé reading of from 35° to 36° when just taken from the evaporator (hot) usually gives a reading of 39° to 41° Baumé when it has cooled to 60° F.

(6) Treatment of finished sirup: When the sirup has reached the proper density it should be quickly removed from the fire and cooled. If the product is cloudy, allow it to settle for several days, if necessary, and then draw off the clear sirup. When the sirup from any variety of sorgo is found to have sugared or crystallized badly after standing for some time, this objection may be overcome, when making sirup again, by use of the invertase process developed by the Bureau of Chemistry, United States Department of Agriculture, Washington, D. C.

(7) Canning or barreling the sirup.

Sugar-Beet Sirup.—After cleaning the beets and removing the tops, cut off the crown, or top portion of the cleaned beets squarely at the line between the green and white portions. If this line extends to a considerable point below the lowest leaf scars, the cut may be made

at the line of the lowest leaf scars and the green portions then removed by being trimmed. The skin or peel should also be removed. These precautions are necessary to make sirup of good flavor. The peeled beets are sliced and the slices allowed to fall directly into hot water of sufficient depth to cover them and prevent access of air. Exposure to air causes a dark color in the sirup and tends to impart an unpleasant flavor. Cut the slices about one-sixteenth inch thick with a large-bladed butcher knife. An ordinary kraut cutter or some type of vegetable-slicing machine is more suitable for handling large quantities. Soak the slices for about an hour at a temperature of 174° to 180° F., keeping the beets just covered with water. Use clean vessels of tin, enamel ware, aluminum, or crockery, or a wooden container such as a barrel, for extracting the juice, but avoid using copper or iron vessels. The extract should be of a pale yellow color and slightly opaque.

The second step is to heat the extract. Use a pressure cooker, pour in the extract, fasten down the cover, and heat to a temperature of 226° to 230° F., maintaining this temperature for an hour. At the end of this time let the steam blow off rapidly, and strain the juice through cheesecloth or muslin. The third step is evaporating the sirup. Place the extract in a kettle made of tin, aluminum, or enamel ware, and evaporate by boiling briskly. A shallow flat pan is more satisfactory, since the evaporation is more rapid and results in a lighter-colored sirup. Remove the scum that collects. The sirup may be evaporated to any density desired. Place it in bottles, jars, or cans that have been cleaned and sterilized. Fill the containers while the sirup is boiling hot, and seal at once in an air-tight manner. The sirup is a light to dark amber color, and may be used as a table sirup and in making candy, dark-colored cake, and sweet bread. It may also be used in place of part of the sugar used in making jams.

Sugar-Cane Sirup.—Sirup, rather than sugar and molasses, is the principal product made from sugar cane in Florida, Georgia, Alabama, Mississippi, and Texas. The small size of individual acreages of cane grown for sirup and the fact that the tonnage produced in a given locality is not always so centrally located as to permit economical transportation to a large steam-operated plant frequently render it necessary for farmers to make sirup on a comparatively small scale. For a season's output of 10,000 gallons or less the small-scale boiling and skimming method which employs a suitably constructed furnace and open evaporator of the continuous type, is the most satisfactory process. By use of an evaporator, rapid evaporation is obtained which is essential in making light-colored sirup. The sirup is concentrated in a thin layer, thus increasing the rate of boiling and foaming and affording a better opportunity for thorough skimming. The use of chemicals and other clarifying agents is practiced for the most part only by the larger manufacturers who use steam for evaporation and may even be able to filter the juice or sirup at any stage.

The larger and stronger power-driven mills give a higher extraction of juice from the cane and a corresponding increase in yield of sirup. The small horse-driven mill seldom, if ever, gives more than 50 per cent extraction, whereas a power-driven mill of the three-roller type will give approximately 60 per cent extraction, and the power-driven three-roller mill pro-

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vided with a two-roller crusher extracts as much as 65 to 67 per cent of juice. Extraction in this case means the weight of juice obtained divided by the weight of cane.

In operation, the juice obtained at the mill is strained through a cloth or sack and also permitted to settle to allow removal of as much as possible of the impurities. It is then run into the first compartment, which is the coolest part of the evaporator. When the furnace is properly constructed, the boiling of the juice increases in vigor toward the back end of the pan as far as the section under which the fire is the hottest. This causes the scum to run, counter to the flow of juice, to the cooler or front portion of the evaporator. Some of the juice is also boiled over the sides to the skimming trough and flows back to the front of the pan. A portion of the skimmings remains in the trough, and the remainder flows to the front of the pan, where it is removed. By the time the juice reaches the hottest part of the pan, which is about 1½ feet beyond the middle, it has been evaporated to semisirup and is fairly well cleaned. As the sirup becomes more concentrated, more flocculated material separates. This should be carefully removed by being skimmed.

A good thermometer is more useful in the control of the operation of an evaporator than is the Baumé spindle or hydrometer often recommended for this purpose. Sirup which tests 38.5° to 39° Baumé (70.8° to 71.8° Brix) at atmospheric temperature, using a hydrometer, boils at 223° to 224° F. (106.7° C.), sea level, at the time when it should be allowed to flow from the evaporator. A sedimentation is in general the most feasible procedure for removal of excessive quantities of suspended material from sirup before either barreling or canning. Sirup that has settled over night, however, should be reheated for canning to the proper canning temperature. To obtain uniformity, the grading and large-scale mixing of sirup of the same grade at a centrally located canning plant is the best plan. Each sirup maker's surplus over what he can sell at a satisfactory price in cans in the local market may be packed in barrels and sold to the canning plant. The invertase process developed by the Bureau of Chemistry, United States Department of Agriculture, Washington, D. C., is the most satisfactory method for preventing sugaring or crystallization. It may be used during the process of concentrating the juice to sirup, or it may be applied to the finished sirup at a central receiving, canning, and marketing plant. In the canning of sirup on a small scale a much higher percentage of perfect closures is obtained with the small friction top than is possible with the large friction-top cans. It is necessary to fill the cans with sirup at the proper temperature (170° to 180° F.) and to obtain absolutely air-tight closure of the cans.

Sweet-Potato Sirup.—Sweet potatoes are a possible source of many products containing or derived from starch, such as potato flour, dehydrated potatoes, starch, sirup, alcohol, vinegar, breakfast foods, and various kinds of feeds. When cooked until soft, crushed into a pulp, cooled to the proper temperature, treated with a little malt, allowed to stand for a short time, and then pressed, they give a sweet juice which may be evaporated to sirup. Because of the large proportion of starch the yield of sirup is high. An average yield of 1.37 gallons of sirup to a 50-pound bushel of potatoes has been obtained. The dried pomace forms from 3½ to 10 per cent of the weight of the potatoes.

FRUIT JUICES AND VINEGARS

Fruit Juices

General.—If the fruit is to be cold-pressed, it usually must be crushed to facilitate the outflow of juice. Exceptions are the citrus fruits, which should be pressed after being cut in two, and pineapples, which may be pressed whole. To increase the juice yield, intensify the color, or impart the desired flavor to the juice, heat the fruit before pressing and omit the crushing. Juices of the small fruits are successfully prepared with or without previous heating. Pineapples, peaches, and the citrus fruits should be cold-pressed. The system of racks and cloths extensively used in the making of grape juice and cider probably is best also for preparing the juices of other fruits. Racks of hard maple are best, as this wood is very strong and flavorless. The press cloths should be of extra heavy quality. A convenient way to remove a greater part of the sediment is to pass the juice through a milk separator, which causes a large portion of the sediment to adhere closely to the walls of the bowl. Filtering through paper pulp also removes much of the sediment. Fruit juices may be Pasteurized in glass bottles or fruit jars.

Apple Juice (Cider).—Two methods have been devised by the Department of Agriculture for the making of sweet cider. The procedure is divided into steps, and it will be noted that steps 1 to 6 and 10 to 13 are identical for the two methods.

Summary of the processes for preparing unfermented apple juices.—

STEPS COMMON TO BOTH METHODS

(1) Select sound, well-matured, properly ripened fruit.

(2) If different varieties are available at the same time, blend them in proper quantity to give a well-balanced cider of good flavor.

(3) Wash and sort the fruit, trimming or discarding all specked or partly decayed apples.

(4) Grind and press, subsequently re-pressing the pomace.

(5) Place the juice in deep containers in a cool room over night to allow the settling out of the pomace.

(6) Siphon off the juice from the sediment.

STEPS USED WITH METHOD I

(7) Place the juice in suitable sterilized containers, seal with sterilized tops, and submerge in cold water in the Pasteurizer. Bring the temperature up to 175° F. and keep it at that point for about 10 minutes. Or (second method) Pasteurize at 175° F. by passing juice through a continuous Pasteurizer, placing it in sterilized containers, and sealing immediately.

STEPS USED WITH METHOD II

(7) Transfer the juice to a suitable vessel or tank, slowly add properly prepared diatomaceous earth at the rate of 6 to 8 pounds per 100 gallons, and stir thoroughly. If the juice is very cold, heat it to 130° F. to aid in filtering.

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(8) Store the juice in a cool, dark room until settling is completed (two weeks to four months). For home use, juice may be left without further treatment until used, if preferred.

(9) (*a*) Siphon off from the storage containers. (*b*) Blend if juices pressed at different periods are being used. (*c*) Clarify further by passing through a pulp filter, milk separator, centrifuge, or flannel filter bag.

(8) Prepare the filter by passing a suspension of diatomaceous earth in water through a filter press or bag filter so as to form a thin layer of earth on the filter cloths.

(9) Filter the juice, stirring the supply tank occasionally in order to prevent the sliming and clogging of the filter.

(10) Place the juice as filtered in previously sterilized final containers, seal, and submerge the containers in cold water in the Pasteurizing tank.

(11) Pasteurize for the prescribed period at 170° F.

(12) Remove from Pasteurizer, and store in a cool room for 10 days or more.

(13) Label and pack.

Federal regulation governing the manufacture and sale of cider and unfermented fruit juices.—As considerable confusion and uncertainty exist in the minds of persons as to the meaning and scope of the laws relating to the manufacture and sale of apple juice or cider, the following extracts from instructions issued by the office of the Federal Prohibition Commissioner of the Bureau of Internal Revenue to prohibition enforcement officers are added in the hope of making the matter clear to those interested. The regulations are subject to modification, and any person planning to manufacture fruit juices for sale should inform himself as to the current regulations by making inquiry of the Federal prohibition director of his State.

Pro. Mim. Coll. No. 2608, Pro. No. 135, issued October 14, 1920. Manufacture of nonintoxicating cider and nonintoxicating fruit juices exclusively for use in the home.

To collectors of internal revenue, federal prohibition directors, supervising Federal prohibition agents and others concerned:

Questions have arisen concerning the application of Pro. Mim. 84, relating to the manufacture of nonintoxicating cider and nonintoxicating fruit juices exclusively for use in the home, to the internal revenue laws. It is hoped that the following statement will make the situation clear:

Cider made and used in the home is not subject to tax under the internal revenue laws, but grape and other fruit juices, not including cider, if fermented to the point where they contain one-half of 1 per cent or more of alcohol by volume, even though not intoxicating, and regardless of section 29, Title II, of the national prohibition act, are subject to tax under the revenue act of 1918 as wine. All persons producing fruit juice other than cider containing one-half of 1 per cent or more of alcohol by volume are required to register in accordance with regulations No. 28, supplement No. 2, and Treasury Decision 2765. Subject to the limitations indicated by Treasury Decision 2765, the head of a family who has properly registered may make 200 gallons exclusively for family use without payment of tax thereon. If he makes more than 200 gallons, he must give bond

and pay tax on the excess. If such excess amount is intoxicating, double the ordinary tax is due as provided by section 35 of Title II of the national prohibition act.

Pro. Mim. 127, issued October 7, 1920. Instructions relative to manufacture of cider, cider vinegar, and nonintoxicating cider.

To Federal prohibition directors and others concerned:

Numerous inquiries are being received in this office relative to the manufacture, sale, and use of cider and the manufacture and sale of cider vinegar.

For the benefit of all concerned the following instructions are issued:

HARD OR FERMENTED CIDER

Section 1 of Title II of the national prohibition act defines "intoxicating liquor" and the definition is held to include hard or fermented cider containing one-half of 1 per cent or more of alcohol by volume.

Any person desiring to manufacture such hard or fermented cider for conversion into vinegar or for other legal nonbeverage purpose is required to qualify by giving bond and procuring a permit. (See reg. 60, arts. 3 and 5, and T. D. 3055.) Such hard or fermented cider may be sold only in quantities of 5 gallons or more by one qualified permittee to another permittee pursuant to permit purchase, Form 1410. Full instructions for the procurement and shipment of such intoxicating liquor under permit to purchase, Form 1410, will be found in article 8 of regulations 60.

It is illegal to possess, except in the home, cider containing one-half of 1 per cent or more of alcohol by volume without a permit. If a person purchases cider for commercial use containing less than one-half of 1 per cent of alcohol by volume and such cider later develops a greater alcoholic content than permitted by law, the person so possessing such cider in good faith may apply for a permit to dispose of the same to another permittee as above provided.

SWEET CIDER CONTAINING LESS THAN ONE-HALF OF 1 PER CENT OF ALCOHOL BY VOLUME

Where the alcoholic content of sweet cider is kept at all times below one-half of 1 per cent by volume the manufacturer or vendor is not required to give bond or obtain a permit either to ship or sell.

Such sweet cider, however, should be sterilized or preserved, and be put up in sterilized glass bottles or other similar closed containers, to insure the alcoholic content remaining less than one-half of 1 per cent by volume until consumption. * * * Sweet apple cider containing less than one-half of 1 per cent of alcohol by volume may be sold in bulk containers, such as barrels, for use in the manufacture of vinegar or apple butter without payment of tax thereon, but the vendee must furnish a written order showing the kind and quantity to be furnished and that the alcoholic content is to be less than one-half of 1 per cent by volume, and the names and addresses of the vendee and vendor, respectively. * * *

Sweet cider direct from the press may be sold to customers by the glass or in other open containers without payment of sales tax, provided that it is not mixed or compounded with any other ingredient and is sold for

consumption at the place of business or in proximity to such place of business.

Farmers or other persons, without obtaining permit or giving bond, may take fresh apples or other fresh fruit to a commercial mill for the purpose of having the juice expressed therefrom, and such fresh juice of the fruit containing one-half of 1 per cent of alcohol by volume may be removed for use in the home exclusively.

Dried fruits, such as raisins, may not legally be used in the manufacture of such nonintoxicating fruit juices exclusively for use in the home.

Full information on these subjects may be obtained from the Federal prohibition directors of the various States.

Blackberry Juice.—Cooking before pressing increases the yield and gives a juice possessing the desirable aroma and flavor of cooked blackberries. Apply the pressure very gradually to avoid pressing the pulp through the press cloths. The juice loses but little flavor and color on being sterilized. The distinctive blackberry color and flavor are well retained for a period of at least six months. Though rather acid, juices of both wild and cultivated varieties are attractive when so prepared.

Huckleberry Juice.—Huckleberries yield their juice readily when pressed either with or without being heated. Juice prepared from berries not heated before being pressed lacks a distinctive flavor; that from cooked fruit possesses a distinctive aroma which is not well retained when juice is kept. It is intensely colored. Huckleberries are not of promise as a source of juice.

Strawberry Juice.—Strawberry juices can be made if berries are heated to 150° F. in closed containers, drained without pressure, and the juice bottled, and Pasteurized at 165° to 170° F. Color and distinctive aroma will be preserved. Strawberry juice is a refreshing beverage, especially when combined with other fruit juices. One of the best combinations is made by the addition of the juice of one lemon to each pint of strawberry juice. This must be sweetened and diluted according to taste.

Cold Storage.—(1) When the preservation of the fresh-fruit flavor is desirable, the following method may be used for packing small quantities of strawberries for use when they are not in season. Select sound, ripe berries; wash, and hull. Use a tin of convenient size to which a tight cover can be fitted. To each 10 pounds of fruit use 1 cupful of sugar; fill the cans with sugar and berries; put on the tops, and cover the edges with adhesive tape such as is used for sealing packages; put in freezing cold storage and keep frozen until wanted. This product can be used for shortcakes by restaurants and hotels, for crushed fruit at soda fountains, and by ice-cream manufacturers.

(2) The large manufacturers of the crushed fruits and sirups used by the soda fountains and ice-cream trades prepare their product as it is needed at any time during the year from uncooked berries which are kept in barrels in cold storage preserved in the following manner: The berries are hulled and sorted. They are then washed by being run on a belt through a tank of water, then over another belt, where they are slowly turned and sprayed with water. The berries then drop into pans and are weighed. To each pound of berries, sugar is added varying from one-half to 1 pound. Usually, however, the proportion is half a pound of sugar to 1 pound of fruit. The proper proportion to use will depend upon the variety,

the ripeness of the fruit, the moisture conditions, and the way in which the product is used. Heavy, tight barrels holding about 375 pounds of the mixture of berries and sugar are used. Before use they are carefully examined and coated on the inside with paraffin, which is applied while hot with a paintbrush. New barrels may need special treatment to prevent berries from absorbing a woody taste.

The sugar and berries are put in alternate layers and mixed by machine or by hand. As soon as the barrels are headed they are shipped in refrigerator cars to a cold-storage warehouse, where they are held at a temperature of 30° F. or lower. After being washed the berries are sometimes dropped into a mixing tank, where the sugar and berries are thoroughly mixed by being constantly stirred. This tank is surrounded with ice water, which cools the fruit before it goes into the barrels. If equal weights of sugar and berries are used, the barrels of fruit may be stored at a temperature of 34° to 36° F., but if the fruit is to be held for long periods the flavor is best preserved at a lower temperature.

Raspberry (Black) Juices.—Juices can easily be prepared from black raspberries if berries are crushed and then pressed with or without being previously heated. The characteristic color and flavor of black raspberry juice are well retained upon sterilization. When properly canned or bottled, the juice will keep for several years. Sterilized juice is rather acid, requiring the addition of sugar to make it palatable.

Raspberry (Red) Juice.—High yields of juice are easily obtained if berries are crushed and pressed. Although red raspberry juices undergo a distinct change in flavor on being heated, the palatability of the juice is not greatly injured. When juice is kept after sterilization, the color fades and disappears and the flavor changes greatly, even though during a period of storage of six months.

Cherry Juice.—High yields of juice are easily obtained if crushed cherries are pressed without being previously heated. The distinctive color and flavor are well retained when juice is heated. Juice prepared from cherries crushed, kernels and all, before being pressed, is slightly better than juice prepared without crushing of the kernels, because it possesses flavors derived from the kernels.

Grape Juice.—Unfermented grape juice is without question the most popular of the fruit beverages. It is one of the few fruit products in which the proportions of sugar, acid, and flavoring substances are so well balanced as to make the unmodified juice a palatable and refreshing drink. It is, further, exceptional in that it undergoes no undesirable changes, such as loss of color or flavor, when Pasteurized and kept in storage. For these reasons the process employed in the making of grape juice is unusually simple and inexpensive, requiring little or no special treatment, and the product is easily preserved.

The following diagrammatic outline may serve to summarize and make clear the steps in the procedure and to contrast the cold-press and hot-press methods when a specially attractive product is to be prepared for sale. When the juice is intended for use in the home, the steps required to make it perfectly clear and free from sediment may be omitted if desired.

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DIAGRAMMATIC OUTLINE OF PROCEDURE IN MAKING UNFERMENTED GRAPE JUICE (STEPS 1 TO 3 AND 6 TO 17, METHODS IDENTICAL)

(1) Select the best available variety.
(2) Gather fruit that is fully ripe, sound, and clean.
(3) Crush the fruit.

STEPS 4 AND 5, COLD-PRESS METHOD

(4) Press the juice from the grapes without heating them.

(5) Allow the juice to stand from 4 to 6 hours for settling.

STEPS 4 AND 5, HOT-PRESS METHOD

(4) (*a*) Place the crushed grapes in enameled dish pans or other enameled vessels. (*b*) Heat with constant stirring to 175° F., using a thermometer for testing. (*c*) Hang the fruit up in a drain bag. (*d*) Press to liberate the hot juice.

(5) Allow the juice to stand and settle until cold (6 to 12 hours).

(6) Strain through clean doubled cheesecloth without disturbing the sediment.

(7) Sweeten, acidify, or blend, if necessary.

(8) Filter through a flannel jelly bag. Juice may also be filtered with diatomaceous earth exactly as directed for apple juice in Method II, steps 7 to 9.

(9) Identical with step 7 in Method I for apple juice.

(10) Store in a cool, dark, dry closet until the juice is cleared by the crystallization and precipitation of argol (4 to 12 months).

(11) Transfer to bottles, filtering to free the juice from sediment.

(12) Cap the bottles.

(13) Pasteurize the bottles by the submersion method at 180° F.

(14) Remove the bottles, place them on their sides, and allow them to cool.

(15) Dip the tops of the corked bottles in a melted mixture consisting of equal parts of rosin and beeswax.

(16) Store the bottles (on their sides) in a dark, dry, cool room.

(17) Label the bottles with the name of the product, the variety of the fruit, the net quantity of the contents, and the name and address of the maker.

Lemon Juice.—At the present time the department is not in a position to suggest a satisfactory method for the preparation of lemon juice, as none has been found for properly retaining the characteristic lemon flavor during keeping at ordinary temperatures. Flavor is well retained, however, for at least several weeks. Other features of the problem of preparing lemon juice have been mastered. The milk separator can be used in removing oil and the bulk of the suspended matter after the juice has been obtained by the cutting and pressing of the fruit.

Orange Juice.—The studies of orange juice have not led to results on which a method for its preparation may be based, as no way to retain successfully the fresh orange-juice flavor has been found. Sterilizing the juice injures the flavor, which continues to deteriorate gradually when the juice is kept at ordinary temperatures. In cold storage, however, the flavor is well retained. Certain

features of the technology of preparing orange juice have been mastered. Thus, the milk separator may be successfully employed in removing excessive quantities of oil as well as suspended matters from freshly expressed juice. Removing the peels before pressing has been found to be inadvisable, as juices so prepared were deficient in orange flavor.

Peach Juice.—Juices are prepared readily through the crushing and pressing of the fruit. They are viscous, and long, slow pressings are necessary. If the kernels are crushed before fruit is pressed a marked pit flavor appears in the juice. Peaches are somewhat less promising as a source of juice than any other kind of fruit.

Pineapple Juice.—In order to avoid soapy flavors, peel pineapples before crushing and pressing them. Heating the juice may cause a slight but definite change in flavor, but does not markedly injure the juice. Gradual darkening will occur when precautions are not taken to exclude atmospheric oxygen in the canning or bottling of the juice.

Vinegars

General.—Vinegar is essentially a dilute solution of acetic acid, made by fermentation processes, containing salts and extracted matter. Sugar is the base of vinegar production. Any watery solution of a fermentable sugar may be transformed into vinegar under favorable conditions. All vinegar is made by two distinct biochemical processes, both of which are the result of the action of microorganisms. The first process is brought about by the action of yeasts which change the sugar into alcohol and carbon dioxide gas. This is the alcoholic fermentation. The second process results from the action of a widely distributed group of bacteria which have the power of combining oxygen with the alcohol, thereby forming acetic acid. This is the acetic fermentation, or acetification.

Fermentation.—The methods of making vinegar differ decidedly, depending upon whether it is made in small quantities as a household product, in larger quantities as a farm product, or in much larger quantities requiring the elaborate equipment of a commercial plant.

Household method.—The best receptacles for the making of vinegar in the home are stone jars that hold 3 to 6 gallons and have straight sides and covers. The following method, which calls for peaches, may be used with a few minor variations for making vinegar from other fruits:

(1) Preparation of mash: Select ripe fruit, approximately 1 bushel. Cut each peach in two and crush with a potato masher. The mash produced will fill a 4-gallon jar about two-thirds full. The stones need not be removed.

(2) Alcoholic fermentation: Add a cake of yeast, which has been mixed with a small portion of the juice, to the jar of peach mash. Cover the jar with a double layer of cheesecloth to prevent the entrance of insects, and with a lid to exclude light. Stir the mash daily to break up surface crusts, to prevent the formation of molds, and to insure a more complete fermentation. As a rule from four to six days are necessary for fermentation.

(3) Acetic fermentation: When the alcoholic fermentation is complete separate the juice from the mash. Usually straining through cheesecloth is sufficient. Complete separation may require the use of a hand press. After the juice has been returned to the jar a starter

in the form of vinegar is added in proportion of 1 part to 4 parts of the juice, and the jar is covered as before. A thin coating or film will appear on the surface of the juice in a few days. This "mother of vinegar" which is composed almost entirely of acetic bacteria is essential for a successful fermentation. Great care, therefore should be taken not to cause it to fall by stirring or agitation. As soon as the juice has reached its maximum acidity the vinegar is filtered and bottled. Vinegar with an acetic strength of 4.5 per cent has been made from peaches in 13 days.

Farm method.—Vinegar as ordinarily produced on American farms is made from apple juice. The following method of making vinegar may be used:

(1) Pressing the fruit. (See Apple Juice.)

(2) Alcoholic fermentation: Let juice stand in loosely covered barrels for a day or two. Add compressed yeast, in the proportion of 1 small cake to 5 gallons of juice. (3) Acetic fermentation: This may be done in any one of the following three ways: (*a*) Slow barrel process, (*b*) continuous process, or (*c*) rolling generator process. The selection of the process will, of course, depend upon individual conditions.

Probably the "slow barrel process" is more generally used. After alcoholic fermentation is complete, draw off the juice, without disturbing the settlings at the bottom, and pass into barrels for the final acetic fermentation. First soak barrels with strong vinegar and place on their sides with bungholes up. Fill about two-thirds full, the aim being to expose as large a surface of juice as possible to the air. Add 3 gallons of good vinegar to each barrel to hasten the change to acetic acid. Leave bungholes open, but cover with cheesecloth or screen to keep out insects and dirt. The temperature should not be below 70° F., if possible. Acetification should be allowed to proceed until a strong vinegar is produced. This will require from three to six months' time.

Berry Vinegar.—Vinegar which can readily be made by household methods from raspberries, blueberries, and doubtless other berries may be very acceptable for certain purposes. Vinegar made from red raspberries will retain indefinitely the odor and flavor of the fruit, which makes it desirable for flavoring food.

Grape Vinegar.—Vinegar of unexcelled quality can be made from the grapes on the Pacific coast of the United States. The white-wine vinegar made from whole white grapes or from the pulp of purple or red grapes is excellent in quality. This must not be confused with what in commerce was formerly called "white-wine vinegar," which is simply a spirit vinegar. Grape juice contains a very much higher proportion of sugar than apple juice; hence a much stronger vinegar can be made from it. Vinegar can also be made from the muscadine grapes grown in the Southern States.

Honey Vinegar.—Vinegar of excellent flavor can be made from unmarketable honey or honey washings. When honey is used for this purpose, it must of course be diluted by the addition of water until it contains about 15 per cent of sugar. As heat must be employed in the process of dilution, it will be necessary to use cultures of yeast and acetic bacteria. The dilution of the honey also reduces the chemical elements which are necessary for the growth of yeasts and bacteria. In order to supply the essential elements, especially nitrogen and phosphates, certain chemicals should be added. The following formula is suggested for a barrel of vinegar: Strained

or extracted honey, 40 to 45 pounds; water, 30 gallons; ammonium phosphate, 2 ounces; potassium tartrate, 2 ounces.

Peach Vinegar.—(See household method of making vinegar.)

Persimmon Vinegar.—Persimmons, which grow in nearly all parts of the United States but most abundantly in the Southern States, are exceedingly rich in sugar, and it has been shown that they may be utilized for making vinegar. In using fruits like persimmons and figs, which have a high sugar and low moisture content, add water to obtain the proper concentration.

Pear Vinegar.—Pears, which are grown in great abundance in many places, may also be utilized for making vinegar. It has been shown that even varieties like the Kieffer, which have a low sugar content, may be made to produce a satisfactory vinegar if well ripened.

Miscellaneous.—*Vinegar from grains.*—Grains, chiefly corn, barley, rye, and oats, are largely utilized for the production of spirit and malt vinegar. The starch which they contain is first converted into sugar, usually by the action of malt (sprouted barley). Malt vinegar is made from the sugary solution or wort obtained by the steeping of crushed malt in warm water.

Vinegar from maple products.—Maple-sirup skimmings or maple sirup which has been scorched may be used for making vinegar. Like honey, this must be diluted until it contains about 15 per cent of sugar, or until it weighs about 9 pounds to the gallon. To each 30 gallons of the diluted sirup, 2 ounces of each of ammonium sulphite and sodium phosphate are added. These chemicals, which are neither expensive nor injurious in the quantities called for, are not to be regarded as adulterants.

Vinegar from molasses.—Molasses, either alone or in combination with grain extracts, is widely used as a basis for making spirit vinegar. Crude molasses, known as blackstrap, is first diluted with hot water and then subjected to alcoholic fermentation. This kind of vinegar is not commonly preferred for table use, but is extensively used for pickling and preserving.

Watermelon vinegar.—Watermelons have been used successfully for making vinegar, but the juice must be concentrated to about half its original volume to give the proper sugar content.

Federal Regulations.—Vinegar may be made in the home and on the farm without a permit if it is to be consumed only in the home or on the farm where it is made. If it is to be offered for sale, the maker must obtain a permit from the collector of internal revenue of his district. Vinegar offered for sale in the United States should contain at least 4 per cent of acetic acid.

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FATS AND OILS

Vegetable Oils

Castor Oil.—To most of us the term castor oil at once brings to mind a nauseous medicine. At one time the castor bean was an important crop in certain sections of Oklahoma, Kansas, Missouri, and Illinois, but in recent years the United States has been able to import from India all the beans required more cheaply than they could be raised in this country. American mills crush the castor beans by using the hydraulic process similar to that of the cottonseed mill. Castor oil is used as a lubricant for high-speed motors, for medicinal purposes, in soap making, in the preparation of sticky fly papers and of imitation leathers, and for many other commercial purposes. The press cake from castor beans contains a poisonous principal which makes it dangerous as a cattle feed, but it has value as a fertilizer.

Coconut Oil.—For many years the United States as a Nation has been using coconut oil in the manufacture of the so-called marine soaps, that is, those soaps which form a lather in alkali and salt waters, to make pharmaceutical preparations, cosmetics, and, to a smaller extent, confectionery and cakes. It is only within the last 10 years that this oil has received attention as a food product. One of the most important uses of the refined coconut oil is the production of vegetable margarines, sometimes called "nut margarines." In the making of these butter substitutes approximately 50 parts of coconut oil, 25 parts of peanut or other vegetable oil, and 25 parts of ripened milk are mixed thoroughly by being churned, and then are quickly chilled. The cooling of the mixture must be done in such a way that the fat particles, when collected and worked, will yield a smooth, butterlike product. This is usually accomplished by either spraying the batch into a large tank of cold water or running it from the churn in a thin sheet under an ice-water spray. After the batch has congealed into a mass of fine, waxlike particles, it usually is collected in large trucks and placed in a tempering room, where it is allowed to ripen and develop a buttery flavor. In a day or two, when properly ripened, it is taken to the workers, the requisite quantity of salt added, and the excess of moisture squeezed out. It is then ready to be placed in packages for the market.

Corn Oil.—Corn oil, which, so far as is known, is made only in this country and Canada, has within the last decade come into prominence as both a food and a technical oil. It is used in various degrees of refinement as a cooking and edible oil, in the manufacture of soap, oilcloth, and rubber substitute. It is made from the germs, which after separation from the body and hull of the grain, are dried and pressed in oil expellers. When pure it is a golden yellow and marked by a pleasing taste and aroma somewhat suggestive of freshly ground grain. The residue of corn-oil extraction is pressed into oil cakes and used as a cattle feed. Although the germ itself is about half oil, only from 3 to 6.5 per cent of the entire kernel is oil. Were it not for the fact that in the preparation of hominy feed, cornstarch, and grits, and sometimes in the making of corn meal and other corn products, the germ is more or less completely separated from the

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rest of the grain, corn oil doubtless would be a mere curiosity, as it would not pay to extract it. It is only within the last few years that the refining processes have been perfected, and this oil is now largely used for edible purposes.

Cottonseed Oil.—The United States produces more cottonseed oil than any other single oil—nearly 1,500,000,000 pounds each year. We likewise consume more of this oil than of all other vegetable oils combined. This is due not only to its suitability for both table and cooking purposes, but also to the fact that it forms the bulk of the lard substitutes, and that the large quantities are employed in the manufacture of oleomargarine, as well as in soap and other technical industries. It is also used as a salad oil for packing sardines and other products. "Choice" oil is of light lemon color, and mild and neutral in flavor. "Prime" oil is slightly darker in color and is sweet in flavor, but without any seedy taste.

The method of pressing American cottonseed oil is typical of the way hot-pressed oils are made, and the machinery and processes used in the production of this oil in the United States are superior to those of any other country. The seed is cleaned, delinted, hulled, and ground through a series of three or more heavy steel rolls, and finally carried into storage bins over the pressroom. The seed is pressed by either the "hydraulic press" or the "expeller press" method. As the yield of oil by either process is only about 45 gallons per ton, or less than 17 per cent of the weight of the seed handled, and as a large part of the ground cake and hulls can be used as feed or fertilizer by the local farmers, the crude-oil mills often are located in the smaller towns throughout the cotton-growing sections. From these the oil is shipped in steel tank cars to more centrally situated refineries, or to the packing houses and cooking-compound manufacturers of the North. It is invariably refined before being used for food, as the crude oil has a very dark red color, and contains substances which develop a disagreeable flavor.

Linseed Oil.—Although linseed oil, which is made from flaxseed, is a staple food in some of the European countries, especially Russia, it has so far been used only for technical purposes in the United States. This is partly because nearly all the American oil is hot-pressed, but more especially because it is much more valuable to the paint and varnish, linoleum, patent-leather, and printing-ink manufacturers than to the food-oil producer. The United States produces and uses more linseed oil than it does of all other purely technical oils combined. Practically all the linseed oil in America is pressed in open-plate hydraulic presses, although there are one or two expeller mills in operation. Flaxseed averages about 35 per cent oil, the press cake usually containing between 6 and 8 per cent of oil, and some loss occurs in milling and cooking. The average American yield is about 16 pounds of oil and 36 pounds of cake per bushel of seed, or an oil production of approximately 27 per cent.

Olive Oil.—The United States imports, largely from Italy, France, and Spain, about 50,000,000 pounds of edible and 5,000,000 pounds of inedible olive oil annually. We produce about 2 per cent of our consumption. Olive oil is probably the most widely known of the virgin oils. It is obtained from the grinding of ripe olives, usually pits and all, in a suitable mill and pressing of the resulting pulp in presses made for this purpose. As the pressure applied to the olives is comparatively light, the oil obtained need only be washed and filtered to yield the pure virgin oil of commerce. The pomace left

from the first pressing is reground, and, after the addition of a little hot water, again is pressed to form lower grades of olive oil. Finally, a very low grade of oil may be obtained from the last cake of extraction with some volatile solvent, such as ordinary gasoline, or, abroad, carbon bisulphide, the solvent, of course, being later boiled off from the oil. Housewives would find it more profitable to use olive oil more generally for cooking purposes. In the average American household it is used only for salads and salad dressing, but it is also excellent for frying. It can be heated to a higher temperature than butter, and it has no disagreeable odor or flavor. After all deep frying, such as fritters, doughnuts, or French fried potatoes, the oil should be strained carefully and placed in a clean, tight bottle for further use.

Peanut Oil.—Peanut oil is one of the most important of the world's food oils, and, like olive oil, can be obtained by cold pressing, and when so made from sound, sweet nuts it need not be refined. Such cold-pressed oils possess a characteristic flavor, which, in the opinion of many consumers, makes them superior, especially for salad purposes, to the oils that are hot-pressed and refined. Cooking the peanuts and subjecting them while hot to a very high pressure, however, gives a larger yield of oil than cold pressing. It is therefore customary when a virgin or cold-pressed oil is made, to regrind and heat the cake, and then to press it the second time to extract as much oil as possible. In Europe the best grades of peanut oil are used for edible purposes. The second-grade oil after being refined is used largely in the manufacture of margarines. Of the nine varieties of peanuts grown in the United States but one variety (the Spanish) should be grown for oil purposes. The analyses of a large number of miscellaneous samples of Virginia and Spanish peanuts show a difference in favor of the latter of about 9 per cent in oil content. The presses and expellers used in making cottonseed oil are also used for making peanut oil, although to make a high-grade peanut oil it will be necessary only to install additional shelling machinery. Peanut meal, a valuable product of oil manufacture, is a highly nutritious stock feed.

Soy-Bean Oil.—The oil content of soy beans varies from 14 to as high as 21 per cent in a few varieties, the average being about 17 per cent. The yield of oil from an acre will average 250 pounds (about 35 gallons), or, based upon the dry shelled beans, 1 ton will produce from 28 to 30 gallons of oil and 1,600 pounds of meal. The cottonseed-oil mills can handle soy-beans with little or no change in their present equipment. Soy-bean oil does not need to be refined for paint and other technical uses. Its flavor is distinctly beany, however, so before it can be used in food products it must be refined and deodorized like cottonseed oil. Even the cold-pressed oil is not edible as it comes from the presses, in which respect the peanut has an advantage over the soy bean. Belonging to the group of drying oils, soy-bean oil more closely resembles in its physical properties linseed and the other drying oils than peanut, cottonseed, and similar semidrying oils. It has therefore been used largely as a substitute for linseed oil in the making of paints, linoleums, and like products. When properly refined it becomes very bland, and can be used in lard substitutes, oleomargarines, and even, perhaps, as a table oil. Soy-bean meal is a first-class stock feed.

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Miscellaneous.—*Mustard-seed oil.*—Mustard oil, not the pungent-smelling, volatile oil, but the bland, fixed oil, can be used in foods, particularly in salad dressing. Formerly a large part of the mustard oil produced in this country was used in our condimental dressings. A large part of this oil is obtained as a by-product in the manufacture of mustard flour and prepared mustards, being expressed from the mustard seeds before they can be properly ground and bolted. In the grain elevators of the great Northwest many hundred tons of wild oil-seeds, principally brown mustard and charlock, are obtained from screenings. One or two firms dealing in such miscellaneous products press these, and mix and market the oil under the label "vegetable oil." This is sold to manufacturers of soap and other technical products.

Palm-kernel oil.—Palm-kernel oil, both chemically and physically similar to coconut oil, is obtained from the palm nut or kernel, the hard interior seed of the fruit of the palm. This oil is used interchangeably with coconut oil in the making of vegetable margarines and other food products.

Palm oil.—The fruit from which the palm kernels are obtained is one of the comparatively few that yield a commercial oil from both the rind, or fleshy portion, and the seeds. Just as the pulp of the olive gives up its oil, the fleshy part of the palm fruits, the color of which is, when ripe, an orange or yellowish brown, yields palm oil. In the United States the yellow unbleached palm oil is used very largely in the tin-plate industry. So far it is almost the only substance which has been found satisfactory as a flux on the discharge side of the pots of melted tin through which the sheet-iron plates are passed to receive their coats of tin. Palm oil can be bleached almost white, in which state it is used in combination with other oil in the production of palm-oil soaps.

Peppermint oil.—The peppermint plant is cultivated as the source of a volatile oil which is widely used in flavoring and as a therapeutic agent. About 90 per cent of the supply of this oil is produced and distilled in an area which has the city of Kalamazoo, Mich., for its center and within a 75-mile radius of that city. The value of the oil depends much upon its composition. The principal constituent, menthyl acetate, possesses a very fragrant minty odor, to which the agreeable aroma of the oil is largely due. The alcoholic constituent, menthol, possesses the well-known penetrating minty odor and characteristic cooling taste. The flavoring properties of the oil are due largely to both the ester and alcoholic constituents, while the medicinal value is attributed to the latter only. For oil extraction the plant is cut down when mature and in full bloom, and allowed to cure like hay. It goes next into large wooden vats through which steam is forced, the heat rupturing the oil cells and permitting the oil to escape with the steam. The oil is separated after the condensation of the steam.

Raisin-seed oil.—In the raisin-seeding industry vast quantities of seed accumulate annually. Occasionally a small quantity of raisin-seed oil is made in the United States. To express the oil it is necessary to decorticate the seed because of the low oil content of the whole seed. However, the oil of the whole seed can be extracted with volatile solvents. The clear, amber-colored fixed oil, useful in soap manufacture, could be produced in large quantities from the waste seeds.

Rapeseed oil.—This oil is obtained from the seeds of the rape plant and is used very largely for lubricating

purposes, after it has been blown with air; but, like nearly all vegetable oils, it can be refined to form a fairly palatable oil. It is also employed in the manufacture of soap and for dressing wool.

Vegetable stearin.—Frequently in the preparation of cottonseed oil a part of the fat is caused to separate by cooling and is then placed on the market as vegetable stearin. It is a term properly applied only to the higher melting portion of vegetable oils separated by the chilling process and recently has been used as a synonym for hydrogenated oil. These hardened fats made by the hydrogenation process, however, should not be confused in this way with the natural vegetable stearins. It is used principally in soap making and vegetable shortenings.

Animal Fats and Oils

Cod and Cod-Liver Oil.—The high-grade "cod oil" of commerce is identically the same as "cod-liver oil," both being extracted from the cod livers. The oil is considered an excellent aid in the treatment of pulmonary diseases and also in various forms of debility, the food value of the pure oil being supplemented by a very small percentage of phosphorous, iodine, and bromine. It is now believed that the very small quantity of iodine and bromine in this and other liver oils plays little and probably no part in connection with its curative and food properties. The high vitamin content of the liver oils is an important constituent, and large quantities of these oils were used to furnish vitamins to children and others in various war-stricken communities of Europe where there was much suffering from malnutrition. "Emulsion" of cod-liver oil is a milklike preparation, the oil being finely divided and held in suspension by the addition and mixing in of glycerin and tragacanth.

Garbage Grease.—Several important potential sources of recoverable fats and oils are still largely overlooked in this country. One of the most promising of these is city garbage. The garbage and similar refuse fats are recovered either by use of a volatile solvent extraction or by the pressure-cooking process. City garbage is usually cooked under pressure in large autoclaves, and the grease which separates from the disintegrated vegetable matter is blown out with live steam through the strainers at the bottom of the tanks. The residue is often dried afterwards and extracted for recovery of the remaining fats, and then sold as tankage. Garbage grease, which is high in animal fat and contains from 7 to 10 per cent of glycerin, constitutes a satisfactory soap stock.

Herring Oil.—A number of varieties of fish are used for oil, and many more yield a small quantity of oil as a by-product from plants where they are canned and dried. Herring oil and other fish oils are classed as technical oils and are used chiefly in the manufacture of leather dressings, soap, and to some extent in making cheap paints.

Horse Oil.—One of the most important of the less common animal oils is horse oil, which is produced from the carcasses of horses, either killed for meat or ordered destroyed by public health officials. This oil is the basis for a large proportion of the commercial neat's-foot oil, which is merely a wintered (not to become cloudy in cold weather) horse oil. In the manufacture of many lubricating greases, horse oil is considered an essential constituent, as it is claimed to be superior to any other fat for mixing with petroleum greases.

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Lard.—Lard occupies the most important place among America's fats, with the possible exception of butter. Butter, however, contains only about 83 per cent of fat, and when the amount of water and salt is deducted from the figures reported for the annual production of butter, lard stands first in the list of our output of animal fats and oils. Probably from 85 to 90 per cent of the entire output of lard from the big packing plants, which produce about one-half of the domestic lard, is of the grade known on the boards of trade as prime steam lard. The rest is the so-called kettle-rendered lard or neutral lard. The smaller packers, local butchers, hog raisers, and farmers, who make the other half, usually produce only the kettle-rendered grade. The distinction between steam and kettle-rendered lard is not entirely one of process, as, in the packing houses at least, only the leaf and back fat are kettle-rendered, all the other fats going into steam lard.

In the making of kettle-rendered lard the leaf fat is pulled from the carcasses while they are still warm and is immediately chilled. When thoroughly cooled, the fat tissue is hashed fine and heated in steam-jacketed kettles until the clear fat, in the form of a light-yellow oil at a temperature of 250° F., separates from the tissues. It is then salted and allowed to stand until fine particles of the fat membranes separate out. Finally, after one or two more settlings, it is drawn off hot into the shipping packages and placed at once in a freezer. The cracklings left in the rendering kettles are either pressed to obtain the residual lard or put into the steam-lard tanks. This rendering of lard in steam-jacketed kettles is merely a safe and convenient modification of the old home method of making lard by cooking the hog fat in a big pan or kettle over an open fire. The kettle-rendered product, therefore, has that characteristic lard flavor so highly prized by those who do not like the new type of lard substitutes.

Neutral lard, or simply "neutral" as the packers call it, is made from the first grades of leaf fat by cooking in much the same manner as the kettle-rendered lard. It is, however, cooked at a lower temperature (126° to 128° F.), so that it retains practically no hog flavor. It is used almost exclusively in the manufacture of oleomargarine.

Steam lard, as the name implies, is rendered by means of live steam. The chopped fats are charged into large steel tanks, and after the cover has been fastened down live steam is turned in through pipes at the bottom of the tanks. When the cooking has proceeded to the point where the melted lard separates from the fat membranes, the steam is turned off and the water and solids allowed to settle, after which the lard is drawn off from the top and the water and tankage dumped out at the bottom. As some darkening of the lard occurs during cooking and its flavor is often too strong, it is customary to bleach and deodorize it.

Compound lard is generally a mixture of lard stearin and cottonseed oil. The most common fraud in the sale of lard is the substitution of "compound" for pure leaf lard.

Lard should be stored in a dry, cool, dark place, since moisture, light, and high temperature affect its quality.

Oleo Stock.—Considering the tallow production, oleo stock must be taken into account, as this is really only a high-grade edible tallow derived from cattle and is used primarily for the manufacture of oleo oil and stearin.

Tallow.—Tallow is third in the domestic production of all fats and oils. The yield of fat from a steer is, on the average, 50 pounds, as against 1 pound from a sheep or goat. The modern packing-house method of handling beef fat is similar to that used in the preparation of hog fats. A larger proportion of lard than of tallow, however, is made in open kettles. In the smaller packing houses, which are not under Federal inspection, practically the entire output of tallow is either sold as such or mixed with cottonseed or some other vegetable oil to form a compound. On the other hand, the big packers convert a great deal of their edible beef fat into oleo oil and stearin. These are separated by a process known as graining, which is similar to "wintering" as applied to vegetable oils, to separate the stearin and produce oils that will not become cloudy in cold weather. The graining process consists in running the melted oleo stock into large truck tanks, which are then wheeled into the graining room, where the stock is allowed to stand undisturbed at the crystallizing temperature of the stearin for a day or longer. When the stearin has separated from the oil, the batch is sent to the pressroom, also kept at a constant temperature, and the semisolid mass of stock is pressed in hydraulic or lever presses. As it runs from the presses the oleo oil is pumped into storage tanks, from which it is barreled either for the export trade or for use in domestic margarine manufacture. The solid cakes of stearin are stripped from the press cloths, melted, and stored in barrels for use in making lard substitutes.

The butter substitutes now on the American market are of two classes—the true oleomargarine, which contains oleo oil and neutral lard, and the vegetable margarines, which contain no animal fats. The vegetable margarines are commonly called "nut margarine," being composed largely of coconut and peanut oils. Both types of margarines show a wide variety of composition.

Wool Grease.—Grease recovered from wool scouring forms the crude lanolin, or wool grease, which when properly refined makes one of the most expensive of our greases, the lanolin of the pharmaceutical trade, and the basis of many ointments and salves.

Fat and Oil Derivatives

General.—Aside from the pure fats and oils produced in this country, there are a number of products that are either glycerides or by-products from the refining of glycerides, largely sodium soaps, mixed with more or less neutral oil. These have been grouped together and, for want of a better term, called fat and oil derivatives. These derivatives fall into two classes. The first class comprises those which are obtained as by-products from refining oils and are known in this country either as soap stock or "foots." To the second class belong the stearins and oils.

Acidulated Soap Stock.—Acidulated soap stock, or black grease, as it is often called, is made by neutralizing with sulphuric acid the caustic soda present in raw "foots."

Cottonseed Foots.—If after the black grease has been neutralized with acid and the small amount of glycerin separated from the large quantity of sodium sulphate liquor formed during the process, the fatty acids are distilled, the resulting product is known as distilled fatty acids or, sometimes, distilled cottonseed foots. By far the greater proportion of foots in this country comes from cottonseed oil. Appreciable quantities of foots are

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derived also from the refining of peanut, coconut, soybean, and other vegetable oils which are treated with caustic soda to make them suitable for food purposes.

Fatty Acids.—Both fatty acids and distilled acids are made largely from cottonseed oil.

Greases.—The various greases, which are usually grouped together under "Packers' and renderers' greases," constitute about 10 per cent of the entire animal and fish oil production, and are handled under numerous more or less loosely defined trade names. Much of the inedible fat of the packing houses goes on the market as white, yellow, or brown grease, being graded according to color and percentage of free fatty acid. These are largely hog fats, but may contain catch-basin skimming, some of the fat from the tankage, and the better grades, rancid lard and crackling greases.

Lard Oil.—Lard oil, which is used as an illuminant in signal lights and miners' lamps and as a lubricant in machine shops, is made by a process of chilling lard, and sometimes other fats, such as horse oil, and pressing out the liquid olein from the higher melting stearin. The olein constitutes the lard oil.

Lard Stearin.—The stearin left from the making of lard oil is often mixed with whole lard to make it firmer in warm weather and is also used in the making of compound lard.

Oleo Oil.—Oleo oil is the oil obtained from animal fat, especially beef fat, by the removal of the tissues and solid fatty acids. It is largely used in the manufacture of oleomargarine.

Tallow and Oleo Stearin.—Stearin consists of solid fats, chiefly glycerides of palmitic and stearic acids. It is a hard, dry, crystalline substance of pearly color. It is extensively used in the manufacture of candles.

Tallow Oil.—Large quantities of the inedible grades of tallow are required by the soap maker and the manufacturer of leather dressings and of lubricating greases, as well as in other technical industries.

Red Oil.—The liquid acids are known in the trade as red oil. It is very largely crude oleic acid, along with varying quantities of linoleic acid and a small quantity of palmitic and stearic acids.

Stearic Acid (Commercial).—The soil acids, known as stearic acid, contain more or less palmitic acid.

DYES AND TANNING

Dyeing

General.—Dyeing is the operation or series of operations by means of which uniform color of a more or less permanent character is produced in the substance of objects.

Theory.—In a true dyeing operation the color is not simply deposited on the surface of the fiber, but saturates and penetrates it at the same time. If a cross section of a dyed fiber is examined under the microscope it will be found that the color extends through the interior, and with but few exceptions (what might be called pigment dyes—dyes of mineral nature precipitated more or less mechanically in the fiber) there is no apparent separation of dyestuff particles from the general substances of the fiber. This saturation of the color through the fiber is generally somewhat gradual, and for complete penetration usually requires a rather prolonged boiling or steeping in the dye bath. Just what causes the combinations of the dyestuff with the fiber, and in what form this combination exists, is not definitely known.

Home Dyeing.—*Equipment.*—For dye pots, common agateware vessels are best and most convenient. Size of pots should vary to accommodate different quantities of material to be dyed. Work may be done over any flat-topped stove. Have one large pot set aside for heating water, another for boiling out the raw goods, and a third for boiling out and brightening the finished materials with soap when very fast colors are used on cotton or linen. Each of these pots should be reserved for its special purpose and not used for dyeing. This will avoid the danger of staining the goods. Heavy glass rods about 2 feet in length and rounded at both ends are best for stirring purposes. Wooden dye sticks are also very serviceable. Use good rubber gloves while dyeing to protect the hands not only from being stained and discolored by the dyes but also from the action of the chemicals. Use a good clothes wringer in wringing out the materials. Keep the rubber rolls clean by scouring with soap immediately after the day's work. Plenty of room should be provided for hanging up the clothes to dry. An ordinary clothesline is the best means of support.

Preparation for dyeing.—In planning to dye a piece of goods, first determine the kind and condition of the fabric, remove all spots and stains, and "strip" the old color, if necessary. One should also know that different dyestuffs, different manipulation of materials, and different operations of equipment are necessary in dyeing wool, silk, vegetable fibers, and combinations of animal and vegetable fibers. The kind of fibers composing the fabric may be determined by mechanical tests, such as by sight and feel, and by chemical tests, like burning, and use of acids, alkalies, and dye tests.

Animal fibers, such as silk and wool, have a high degree of resiliency or elasticity. Vegetable fibers have greater absorbent qualities, particularly linen fabrics. Dyeing is successful only on clean fabric and is not a substitute for cleaning. The fabric must be thoroughly cleaned and free from spots before entering the dye bath.

Stripping of colors.—Before a piece of goods is dyed it is often necessary to strip or remove the original color. The object of stripping is to obtain a light-colored bottom on which to dye another color. Stripping must also be resorted to at times when too heavy a shade is obtained in dyeing and, if necessary, to remove some of the color on the fiber to match a shade. One of the principal difficulties in the dyeing of garments is the application of

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dyestuffs to fabrics which are badly sunburned, scorched, faded, or damaged by improper chemical treatment.

Acid colors: Many acid dyes may be stripped without harm to the fabric if boiled for 30 minutes in a water solution containing 2 to 5 pounds of ammonium acetate to each 100 gallons of water.

To make ammonium acetate, take 31 ounces of 26 per cent ammonia and 28¼ ounces of 28 per cent acetic acid; add the acetic acid slowly to the ammonia, stirring constantly, and then add all the Glauber salt that the solution will absorb. Use 1 pint of this solution in 5 gallons of water for stripping.

A complete stripping may be given all fabrics if they are boiled 30 minutes in a solution of 2 per cent formic acid or 10 per cent acetic acid, and 3 to 5 per cent hydrosulphite of soda. This process not only removes color but many stains of a mineral character. Stripping should be done in a wooden or crockery vat. Three or four rinses are necessary.

In the dyeing of badly sunburnt fabrics the reduction of color by means of the foregoing hydrosulphite process is greatly assisted by a sodium-peroxide bleach, which removes color or stains produced by the hydrosulphite bleach. Add hydrosulphite gradually, starting with a weak solution and gradually building it up.

The bleaching solution may be prepared in wooden or crockery vats as follows: For each 25 gallons of water add 4 to 6 ounces of sodium peroxide and 1 pound of magnesium sulphate (Epsom salts) as follows: Dissolve magnesium sulphate in warm water in a separate receptacle, then add to the bath. Dissolve sodium peroxide slowly in cold water and add to bath. The temperature of this bath should not exceed 120° F. Place the fabric in this bath, turn for about five minutes and leave over night; then give it an acetic-acid sour and two cold rinses. It is then ready for dyeing.

Mordant colors: Usually difficult to remove. Many uneven shades, being difficult to correct, must be redyed to a darker color or to black. Stripping can sometimes be partially done if the dyed wool is boiled in a fairly strong solution of sulphuric, hydrochloric, or oxalic acid whereby the dyestuff color-lake is more or less decomposed. If the acid treatment is followed with a warm ammonia bath the dye that is split away from the mordant may be removed.

Substantive dyes on cotton: May be partially stripped if boiled in water containing a small quantity of soda ash in solution or a weak solution of bleaching powder.

Sulphur dyes on cotton: Run through a hot solution of sodium sulphide for a light stripping. Treat the dyed material in a bath of bleaching powder, and acidulate with acetic acid for a complete stripping of color.

Colors.—According to the standard color card of America issued by the Textile Color Card Association of America, there are 17,424 possible combinations without consideration of other intermediate shades. Light colors can be dyed to the original shade or to any shade darker than their own color. Light colors can also be dyed to shades other than original color, provided the new color is considerably darker than the original and has for one of its components the original color.

Yellow, red, and blue are primary colors. Orange, green, and violet are secondary colors. Yellow and red make orange, yellow and blue make green, red and blue make violet, and blue, red, and yellow make gray. This scheme constitutes the basis of all color combinations, and if the proportions are varied all shades may be obtained. Orange and blue, green and red, and violet and yellow are complementary colors.

Color chart [1]

Color	Black	Navy blue	Dark green	Medium green	Dark brown	Medium brown	Old rose	Purple	Red	Light blue
Light blue to	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes.
Navy blue to	Yes	Yes	No	No	No	No	No	No	No	No.
Tan to	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No.
Deep brown to	Yes	No	No	No	Yes	No	No	No	No	No.
Yellow to	Yes	No	Yes	Yes	Yes	Yes	No	Yes	No	Yes.
Dark green to	Yes	No	Yes	No	No	No	No	No	No	No.
Gray to	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes.
Lavender to	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes.
Purple to	Yes	No	No	No	No	No	No	No	Yes	No.
Old rose to	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No.
Dark red to	Yes	No	No	No	No	No	No	No	Yes	No.

[1] Courtesy of National Association of Dyers and Cleaners.

Dyes and Dyestuffs

Artificial Dyestuffs (Coal-Tar Colors).—Most of the artificial dyes are made from coal tar, a by-product from coal gas, producer gas, and coke-oven plants. It is systematically recovered and shipped to the tar works, where it is distilled. The crude distillates or fractions are redistilled for conversion into middle products, which in their turn constitute the raw material for the advanced final processes. As the temperature of the still is increased, various fractions are obtained—first a little ammonia water, then the light oils, followed by the carbolic oils, the heavy oil, and finally anthracene oil. The residue in the still is pitch, of no value for further treatment except as a substitute for asphalt in paving or for making roofing materials and paints.

From each of these fractions is obtained a variety of initial products, which are subjected to refining operations fitting them for further treatment. The light oils when refined yield benzol, toluol, and xylol, products of the greatest importance to dyers, and to the dye and the rubber manufacturers. Benzol, by proper treatment, yields aniline, an oil used for dyeing fast black on cotton hosiery, as well as serving as a raw material for a long line of aniline dyes. The carbolic oils yield phenol or carbolic acid, and form the raw material for an extensive series of middle products ultimately yielding many dyestuffs. Carbolic acid is consumed in immense quantities for producing picric acid, a base for many high explosives. This fraction also yields the major portion of naphthalene which is the most important raw material for dyestuff manufacture. Anthracene oil yields anthracene, which in turn yields alizarin and other important dyestuffs. From these raw products obtained from coal tar many intermediary materials are obtained by complicated and expensive processes before the final dyestuff is produced.

Natural Dyestuffs.—The coloring matter obtained from logwood is outstanding among natural dyestuffs. Logwood comes into commerce in the form of logs, chips, and extracts. Fustic is the heartwood of a certain species of tree found in the West Indies and tropical South America. It is sold as chips and extracts and is chiefly used in the dyeing of wool. Cutch, or catechu, which is obtained from India, appears in commerce in dark-brown lumps, which form a dark-brown solution with water. It contains tannin and catechin and is used extensively in weighting black silks, as a mordant for certain basic coal-tar dyes, as a brown dye on cotton, and for calico printing. Indigo is obtained from the glucoside indican existing in the indigo plant and in woad, and is one of the oldest dyestuffs. It is obtained from the plant by a process of fermentation and oxidation. It appears in commerce in dark-blue cubical cakes. Indigo at present is being produced synthetically on a commercial scale.

Synthetic Dyes.—The common idea that natural dyestuffs are better than artificial or synthetic dyes is not true. With the exception of logwood, practically all natural dyestuffs give poorer results than do the synthetic dyes. The coloring materials in almost all the natural products have been made synthetically, and colors thus obtained are purer, easier to use, and mostly less expensive than the natural product. Dye mixtures in packages can be purchased at many stores, together with instructions for dyeing. It is sometimes difficult

to match shades exactly, however, since two packages labeled the same way may contain different mixtures. Thus, they will not give identical colors when the cloth or material is dyed.

Mineral Dyes.—Since the discovery of aniline colors, mineral dyes have lost much of their former importance. They are still largely used on account of their fastness and the low cost of their production. They are totally different from the natural and artificial organic coloring matters both in their general chemical characters and their tinctorial properties and methods of application. The mineral dyes that are now used to any considerable extent in dyeing are chrome yellow, chrome orange, chrome green, manganese brown, iron buff and Nanking yellow, khaki colors, and Prussian blue.

Mordants

General.—The name is derived from the French word mordre, meaning to bite or corrode. Mordants are divided into three classes:

(1) Metallic mordants, such as chrome, alum, bluestone, copperas, tin salts, and titanium salts. These are salts of the heavy metals, and practically any such salt may be used. They may be used to combine directly with the fiber, as in the ordinary process of mordanting wool, or they may be used in combinations with tannin so as to be fixed in the fiber, as in mordanting silk and cotton. They also may be used in combination with a fatty acid for purposes of fixation, as in mordanting cotton with alum for dyeing Turkey red.

(2) Tannin mordants, such as cutch, sumac, and tannin acid. These mordants are used either as indicated above for fixing metallic mordants, or more specifically as mordants in themselves for the dyeing of basic colors on cotton.

(3) Oil mordants, such as Turkey-red oil, Gallipoli oil, and fatty acids. The oil mordants consist of fatty acids in one form or another and are used to a rather slight extent and almost exclusively for the fixation of metallic bases in cotton dyeing.

Methods of Setting Colors.—Soaking cotton fabrics in solutions of salt, alum, pepper, or other substances as a means of setting the color is largely a waste of time and materials. If there were any such easy method of making dyes fast, the manufacturer would have used it even on his cheapest grades of gingham or calico before he put it on the market. Salt, vinegar, and other materials used in dyeing are not mordants. They do not help to hold the dye on the fiber. When used in connection with the dyeing process, however, they affect the shade and the quantity of dye deposited, and hence are of value in this respect. Also the color will not run from a dyed fabric while it is soaking in a saturated solution of salt or alum as it does in clear water. These two facts probably have given rise to the belief that such a solution sets color. This treatment does not have any permanent effect on dye, and when the fabric is washed later in the ordinary way the color is just as likely to run.

Tanning

Hides and Skins—*Sources.*—Domesticated farm and ranch animals are the most important sources of hides and skins for leather. Other sources include the buffalo, deer, kangaroo, alligator, hair seal, walrus, shark, hippopotamus, elephant, rhinoceros, snake, and lizard. Fur skins are obtained chiefly from the wild fur-bearing animals.

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Hides.—A trade classification based primarily on size distinguishes hides from skins. Hides are obtained from the larger animals such as steers, cows, buffaloes, and horses. Cattle hides, depending upon their weight, are made into sole, belting, harness, lace, welting, case, bag, and strap leather. Splits are also made from these hides and are used for several purposes, but chiefly for shoe "uppers" and upholstery. Genuine Cordovan shoe-upper leather is made from horsehides, as are also heavy work gloves.

Skins.—Skins are obtained from the smaller animals, which include calves, sheep and lambs, goats and kids, pigs, deer, and the like. Calfskins are made principally into upper leather for shoes, while some are used for gloves, bookbindings, and fancy articles. Sheepskin leather serves for many purposes, including uppers for shoes and slippers, gloves, linings for various leather articles, bookbindings, covers, bellows, aprons, chamois, and novelties. Most of the goatskins are tanned into upper leather, of which "glazed kid" is a well-known example, but some bookbinding, glove, and fancy leather is also made from these skins. Pigskins are used for saddle leather, puttees, bookbinding leather, insoles, and traveling bags.

Packer hides.—Another trade classification based primarily on average quality distinguishes between "packer" hides and "country" hides. Packer hides are those hides and skins taken off and cured at the large meat-packing houses. They are handled efficiently by skilled laborers and as a result generally are of better quality than country hides and bring a better price.

Country hides.—Country hides are taken off by farmers and small butchers who generally are inexperienced in skinning and curing. These hides originate in small lots in scattered sections of the country, and unfortunately many of them are not properly skinned and cured. Some are handled several times before being sold to the tanner.

Grades.—Hides and skins are graded No. 1, No. 2, and glue stock, depending upon condition with respect to cuts, pattern, grub holes, and rot. A No. 2 hide generally sells for 1 cent a pound less than a No. 1. Glue stock is worth practically nothing.

Classes.—There are numerous classes for both packer and country hides. A comparative schedule of these classes in so far as feasible is given below. The weights refer to the weight of the green-salted, cured hide or skin.

Packer hides and skins	Country hides and skins
Spready native steers, 60 pounds up.	None.
Heavy native steers, 60 pounds up.	Heavy native steers, 60 pounds up.
Light native steers, 50 to 60 pounds.	Light native steers, 50 to 60 pounds.
Extreme light native steers, 25 to 50 pounds.	Buffs (steers), 45 to 50 pounds. Extremes (steers), 25 to 45 pounds.
Heavy native cows, 55 pounds up.	Buffs (cows), 45 to 60 pounds. Heavy native cows, 60 pounds up.
Light native cows, 25 to 55 pounds.	Buffs (cows), 45 to 60 pounds. Extremes (cows), 25 to 45 pounds.

Packer hides and skins	Country hides and skins
Heavy Colorado steers, 60 pounds and up. Light Colorado steers, 50 to 60 pounds. Branded cows, including Colorado steers, 25 to 50 pounds. Heavy butt-branded hides, 60 pounds up. Light butt-branded hides, 50 to 60 pounds. Extreme light butt-branded hides, 25 to 50 pounds.	Branded hides, except branded bulls, 25 pounds up. (In some sections butt-branded steer hides are classed as No. 2, native steers, buffs, or extremes, according to weight.)
Native bulls, all weights	Heavy native bulls, 60 pounds and up. Buffs (bulls), 45 to 60 pounds. Extremes (bulls), 25 to 45 pounds.
Branded bulls, all weights	Branded bulls, 25 pounds and up. Special selections for branded bull hides, 60 pounds up.
Kips, 15 to 25 pounds	Kips, 15 to 25 pounds.
Heavy calf, 8 to 15 pounds	Heavy calf, 8 to 15 pounds.
Light calf, 7 to 8 pounds	Light calf, 7 to 8 pounds.
Deacons, up to 7 pounds	Deacons, up to 7 pounds.

Quality.—Farmers and ranchmen can help to control causes that affect the quality of hides and skins, like grubworm holes, mange scars, brand marks, tick bites, and wire cuts. These not only lower the value of the hide but affect the health of the animal, and lower its milk and meat yields, its usefulness and value. Other causes of poor quality can occur after the animal is dead and during the skinning, curing, and marketing.

Skinning.—A properly skinned hide is of correct pattern and free from meat, sinews, bag, tail bone, horns, and dewclaws. Clean the hide while it is on the animal, and keep it clean and free from blood during skinning. Stick the throat lengthwise and remove the hide before the animal heat escapes. The best skinning job is done with a keen, sharp knife, but do not use it more than necessary. Make opening-up cuts with straight, smooth edges, not jagged ones. Do not cut into the hide, yet do not leave meat on it. Cuts lower the value of the hide. Meat interferes with its cure. Pull and work off the hide wherever possible. The knife need be used but little on calves and sheep.

Pattern.—The ripping-open cuts down the head and belly and out to the legs control the pattern, which should be such that the shoulder, belly, and butt portions are properly distributed. Start from the belly cut well forward at the brisket, and cut slantingly back to the back of knuckle joint of the foreleg. To cut out the hind legs start at belly cut at a point about midway between tail and bag, but nearer to the bag by a few inches, and cut upward to the back of the hind leg at the knee joint.

Curing.—Much of the value of a hide or skin depends upon its cure. Curing is not tanning, but a treatment to preserve the hide temporarily. A piece of rawhide will spoil just as quickly as so much meat. There are three

methods of curing known as green-salted, dry-salted, and flint-dried. The first is generally used, particularly where salt is readily available and the climate is humid.

Curing must not be delayed. See that the hide or skin is clean, and spread it out smooth, hair side down, in a cool place like a cellar. Remove any meat, trim ragged edges, and split the ears lengthwise twice. Just as soon as the animal heat has escaped spread clean crystal salt about the size of a pea, or ordinary salt such as is used for meat curing, over all parts of the flesh side. See that every spot is salted, for any spot not salted will rot. Rub the salt in along cut edges, head, neck, legs, wrinkles, and heavier portions. A liquor will form at first and should be drained away. In 10 to 20 days the hide will become firmer and be known as salt firm or salt hard. It then can be bundled and can be shipped or safely stored for two or three months. Such a hide is known as green-salted. Dry-salted hides are salted as described and then dried in the air while protected from the weather. Flint-dried hides are cured by air-drying without salt, a practice often followed in hot, dry regions. Green-salted hides are generally in better condition. A well-cured hide or skin is firm, not mushy, free from a disagreeable odor, contains no rotten spots, and the hair does not slip. Do not let hides heat or freeze or lie in water puddles. It is best not to hold them over the summer. Sheepskins and lambskins should be marketed soon after being salted, since they heat up quickly, especially if piled.

Marketing.—The more directly the farmer trades the greater should be his return; however, selling directly to a tanner will seldom be feasible. Locate the largest and most reliable hide dealers, and deal directly with them. Hides and skins, except sheepskins, do not need to be sold at once. When shipping, bundle and tag them securely. If the tag can not be read, or if it comes off, the shipment may be lost.

Fur skins.—Fur skins require special handling. Every effort should be made to follow the best practices of skinning and curing in order to obtain a skin of the greatest possible value. Certain trade customs also must be followed to obtain top prices. Usually fur skins are "cased," that is, not ripped down the belly and legs, and almost invariably they are not salted, but are cured by being dried on boards or frames.

Methods—*Oil tanning.*—The best example of an oil tannage is the familiar chamois leather used for polishing and for jewelry cases. It is almost invariably made from the flesh side or split of sheepskins by the use of marine oils, and is distinguished by its remarkable softness and texture. It is little affected by water and is more difficult to dye than other kinds of leather.

Mineral tanning.—Alum: Alum tannage is one of the oldest tanning processes. Common alum, together with salt and soda, is generally used. Alum-tanned leather in the natural state is white. A good example of this tannage is lace leather, and also the pure-white, soft, dress-glove leather, which is frequently made with a mixture of alum, salt, flour, and egg yolk. Since alum can be washed out of the skin, this process is often referred to as "tawing," to distinguish it from the other tanning processes that yield a permanent leather affected but little by water.

Chrome: Chrome tanning is a relatively modern process, having come into general use only during the last 25 years. Its name is derived from the chemicals containing chromium or "chrome." It is a very rapid

process and produces a leather that has many desirable properties. In its natural state chrome leather is blue to green, but, with the exception of chrome sole leather, it is almost invariably dyed before being finished. Ninety per cent of our shoe-upper leather is chrome tanned. Chrome sole leather, if waxed, is very durable and should be particularly good for children's shoes and work shoes. Unwaxed chrome sole leather is not suitable for outdoor wear because it is very easily penetrated by moisture.

Vegetable or bark tanning.—Vegetable tanning is a very old process, which derives its name from the use of tannin, a product occurring naturally in the bark, wood, fruit, leaf, or root of trees and plants. In commerce many materials, foreign as well as domestic, are used. Sometimes these are crushed or ground and thus used, but often an extract, varying from a thick, sirupy liquid to a crystalline powder and containing from 25 to 65 per cent of tannin, is made from them for the tanner's use. These are known as tannin extracts. Our important domestic tannin materials are chestnut wood, oak and hemlock barks, and sumac leaves. Most of our heavy leather, including sole, belting, harness, and strap leather, is vegetable tanned.

Combination tanning.—Tanning by a combination of processes, generally two, is known as combination tanning. Usually the processes are carried out separately, one following the other, as, for example, chrome tanning first, followed by retanning by the vegetable process.

Having hides tanned.—Tanning is a difficult art with which the inexperienced often fail, especially from the standpoint of appearance. It is never advisable for an inexperienced person to try to tan valuable fur skins, or large hides to be made into coats, robes, or rugs. If the small producer of hides and skins needs leather as such, probably he can get the best return by having the hides or skins tanned by a tanner. Some tanners will tan one or more hides for an individual, but not all will do this. Some will accept one-half of the hide as pay for tanning the other half, while others will tan a hide or skin at a certain price. Depending upon the size of the hide, the kind of leather, and so on, the charge for tanning a hide with the hair on or making it into leather varies from $1.50 to $4 for calfskins and from $5 to $8 for a hide, or from 25 to 50 cents a square foot or a pound for horse and cattle hides tanned into harness, lace, or glove leather. Definite prices, however, must be obtained directly from the tanner. A partial list of tanners who tan leather and furs for farmers may be obtained from the Bureau of Chemistry, Washington, D. C. Possibly others in certain sections of the country can be located by county agents or those interested.

Home tanning.—Home tanning should not be advocated except when the hide or skin will otherwise be a complete loss or can not be sold at a fair return. Often the inexperienced tanner will not be successful; on the other hand, by carefully following detailed directions he may be able to make leather serviceable for many farm purposes. Directions can not be given here, for if given at all they must be presented in the greatest detail to insure the best chances for success.

Materials.—For bark or vegetable-tanned leather a weak infusion of tannin obtained by soaking finely crushed or ground oak bark, hemlock bark, chestnut bark, or sumac leaves in hot water may be used to start the tanning. Later fresh, ground material is placed directly in the tanning vat or vessel. Chemicals for chrome and

alum-tanned leather should be obtained from the nearest wholesale drug store or from the large chemical houses listed in most commercial registers.

Leather Dyeing and Staining.—Very often a satisfactory job of dyeing requires considerable skill, knowledge, and equipment, particularly for whole skins or large pieces. Sometimes, however, ready-made preparations may be used with fair success. Coal-tar dyes and natural wood dyes are used, with and without mordants. The dye may be applied by immersing the wet skin or leather in a large agateware tray or pan containing the dye solution, or by brushing on with a cloth pad, sponge, or brush. Dipping is likely to give more uniform results. The surface of the leather must be clean, free from grease particularly. The leather preferably should be uniformly wet or damp, as application of dye to dry leather is likely to produce uneven coloring. Some of the ready-made preparations for staining leather, however, can be used only on dry leather. Some of the large manufacturers of dyes specialize in dyes for various purposes, including dyes for leather.

Leather Goods

Selection.—Bags, folders, pocketbooks, brief cases, and other articles subject to abrasive wear give better service and retain their original appearance longer if made of leather with a smooth, rather than an embossed, finish. Close examination of a smooth-finish leather shows whether it is a grain or a split piece, an important thing to know, as grain leather is more serviceable. In grain leather the many fine hair holes in the skin are apparent. Of articles made of undyed russet leather the darker shades usually give the best service. Light-colored leather is soon soiled and often has been bleached by chemicals which may be left in the leather to its detriment.

For comfort and health as well as service select shoes that give the toes a chance to spread, that have straight inner lines, well-rounded toes, reasonably thick outsoles, and low, broad heels.

Good harness is sewed well and riveted securely. It should be sufficiently heavy and stout for the work required. It is more economical to buy harness that is too heavy than to buy that which is too light for the work. New harness should not crack on the grain side when sharply bent. It should not be hard and stiff. It should contain about 25 per cent of grease, yet it should not feel greasy.

The best driving belt is cut from center stock or the middle portion of the hide. Leather from other sections is more stretchy and less durable. In selecting a belt obtain a competent belt maker's advice. It is more economical to get a belt that is too wide than one that is too narrow. Although a new belt should contain grease, it should not feel greasy. It is flexible and feels firm, mellow, and smooth. A dull, oily finish is better than a high, glossy one. Joints should be strong and well jointed. "Shimming," or the use of thin strips of leather between plies to make a uniform thickness, is objectionable.

Care—*Boots and shoes.*—Shoes for dress should be cleaned and polished frequently. Those for farm and heavy outdoor work should be kept cleaned and greased. Water and mud destroy leather, but oil and grease preserve it. Wet leather wears quickly, and a shoe if worn long while wet may be completely ruined. Wet leather

burns more easily than dry leather. It should never be allowed to get hotter than the hand can bear. Do not dry wet shoes in an oven, under a hot stove, or against steam pipes and radiators. Clean them of dirt, stuff them into proper shape with paper or a shoe-tree, and let them dry slowly. If for work, they should be well oiled while wet or damp with neat's-foot, cod, or castor oil, tallow, and wool grease, or mixtures of them. Oiled shoes can not be polished. Repairing should be done promptly. As soon as a seam rips, a sole or heel-lift wears through, a heel twists out of shape, or a crack develops in the upper, fix it. Much of the repairing can be done at home with a repair kit.

Waterproofing shoes.—Shoes and boots for rough outdoor work will last longer and protect the feet better if waterprofed. This can be done easily if the shoe is set for about 15 minutes in a shallow pan containing enough of melted waterproofing material to cover entirely the sole and welt. The grease must not be hotter than the hand can bear. For rubber-heeled shoes use a pie pan and keep the heels outside of the pan. Waterproofing mixtures of the following formulas have been found satisfactory.

	Ounces
Formula 1:	
Neutral wool grease	8
Dark petrolatum	4
Paraffin wax	4
Formula 2:	
Petrolatum	16
Beeswax	2
Formula 3:	
Petrolatum	8
Paraffin wax	4
Wool grease	4
Crude turpentine gum	2
Formula 4:	
Tallow	12
Cod oil	4

Harness.—Harness should be kept clean and well oiled. Rips should be sewed promptly and loose buckles securely fastened. Wash and oil harness frequently. For washing use tepid water and a neutral soap, such as castile or a white toilet soap. Scrape off caked grease. Hang the harness in a warm place until it is no longer wet but still damp; then oil it. For driving harness use neat's-foot or castor oil, or a mixture of these with wool grease. For heavy harness use a mixture of tallow or cod oil, neat's-foot oil and tallow, or any of these with wool grease to make a paste. Harness must be oiled while damp, otherwise it will take up too much oil or grease. Remove the excess oil with a clean, dry cloth. Harness should not look or feel greasy.

Belt dressing.—Keep belts from getting hard and cracky. Scrape off all cakes of grease and dirt, especially on the pulley side. Wash off the belt with warm water and a neutral soap, but wash rapidly, never letting the belt get wet, as it will then stretch and slip and the joints may come loose. Apply the dressing evenly to the outside of the belt while it is at rest. Rub it in well with a piece of felt and let it stay over night. Avoid an excess of dressing. Belts should never feel greasy. If absolutely necessary a very light dressing may be applied to the pulley side of the belt by use of cotton waste or felt lightly greased with the dressing. A good ready-made dressing may be used as may also mixtures of cod and neat's-foot oils with tallow and wool grease. A belt should run true and slack rather than tight. It should not slip on the pulley. Not only is power thus lost, but the belt becomes heated and glazed, and its deterioration is hastened.

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Leather bindings.—In the course of time many leather articles become dry, harsh, cracky, and powdery, especially if kept in very warm and dry places. Leather bindings of books are particularly prone to this deterioration due often to the presence of harmful acids and to the use of improper tannin materials, known technically as catechol tannins. The life of leather bindings and of other leather articles can be materially prolonged by frequent light oiling with pure castor oil, or neat's-foot oil, or a high-grade vaseline or petrolatum of U. S. P. quality. The application of any oil or grease to light-colored leather will darken it to some extent. Bindings and other articles should be lightly greased or oiled by the rubbing in of small quantities, preferably with the hand. Be careful not to apply so much that the leather becomes greasy. It is better to make several applications of small quantities rather than to use too much at first. Light, uniform applications may be made with a small ball of oily cheesecloth or muslin.

Pocketbooks.—Carry bill folds, wallets, and pocketbooks so that they will be subjected to the least amount of bending and folding and least exposed to perspiration.

Renovation.—Many leather articles, particularly shoes, traveling bags, suit cases, and hand bags, can be decidedly improved in appearance by the application of ready-made preparations for dyeing and shining leather. Especially is this true when stained light-colored goods can be dyed a darker color. Stains can seldom be removed from leather without disturbance of the finish, and often the only practical remedy is to cover them. Sometimes the leather can be cleaned if a saddle soap is applied with a moist sponge and then rubbed with a clean, dry cloth. Oil and grease spots can sometimes be removed with clean gasoline, or by the coating of the spot with a thick and quick-drying rubber cement, and then the peeling off of the coating when it is almost dry. It may be necessary to repeat the operation several times.

Sometimes when the surface of traveling bags, suit cases, brief cases, or upholstery leather becomes worn and powdery its condition can be improved by the application of a good saddle soap or leather-dressing preparation or a mixture of natural-wool grease, 8 ounces; dark petrolatum, 4 ounces; paraffin wax, 4 ounces, thinned down while melted with an equal volume of turpentine and used cold. Apply lightly and evenly, and rub well.

Mildew.—Leather kept in a warm, damp, dark place is almost certain to mildew. The simplest way to prevent mildew is to keep the leather in a well-ventilated, dry, well-lighted place. When mildew develops wash it off with warm water and soap, or simply wipe it off with a moist cloth, and dry the leather well afterwards.

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5. ANIMAL DISEASES, PARASITES, AND OTHER ABNORMAL CONDITIONS

.0 General.
.1 Horses, mules, and asses.
 .10 General.
 .11 Transmissible diseases.
  .110 General.
  .111 Most frequently observed.
   .1110 General.
   .1111 Anthrax.
   .1112 Distemper.
   .1113 Infectious abortion.
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   .1119 Miscellaneous.
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   .1121 Dourine.
   .1122 Fistula and poll-evil.
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   .1129 Miscellaneous.
  .119 Miscellaneous.
 .12 Nontransmissible diseases.
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  .121 Azoturia.
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 .13 Parasites and parasitic diseases.
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  .135 Pinworm.
  .136 Roundworm.
  .139 Miscellaneous.
 .14 Other abnormal conditions.
  .140 General.
  .141 Colic.
  .142 Curb, thoroughpin, spavin.
  .143 Difficult parturition.
  .144 Galls, corns, boils.
  .145 Heat stroke.
  .146 Knuckling, interfering, stringhalt.
  .147 Ringbone, sidebone, splint.
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   .1491 Choke.
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.1 Horses, mules, and asses—Continued.
.14 Other abnormal conditions—Continued.
.149 Miscellaneous—Continued.
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.1497 Roaring.
.1498 Sand crack, sweeny.
.19 Miscellaneous.
.2 Cattle.
.20 General.
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.210 General.
.211 Most frequently observed.
.2110 General.
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.2113 Cowpox.
.2114 Hemorrhagic septicemia.
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.2116 Pink eye.
.2117 Tuberculosis.
.2119 Miscellaneous.
.212 Less frequently observed.
.2120 General.
.2121 Foot-and-mouth disease.
.2122 Johne's disease.
.2123 Lump jaw.
.2124 Rabies.
.2125 Sore mouth.
.2126 Tick fever.
.2127 White scours of calves.
.2129 Miscellaneous.
.219 Miscellaneous.
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.220 General.
.221 Ergotism.
.222 Garget.
.223 Milk fever.
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.229 Miscellaneous.
.23 Parasites and parasitic diseases.
.230 General.
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.232 Lice.
.233 Lungworm.
.234 Mange, scab, itch.
.235 Ringworm.
.236 Roundworm.
.237 Stomach worm.
.238 Warbles.
.239 Miscellaneous.
.2391 Screw worm.
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.24 Other abnormal conditions.
.240 General.
.241 Bloat.
.242 Casting the withers.
.243 Constipation.
.244 Diarrhea.
.245 Foul of the foot.
.246 Fractures.
.247 Poisoning.
.248 Retained afterbirth.
.249 Miscellaneous.
.2491 Teat obstruction.
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.29 Miscellaneous.

.3 Sheep and goats.
.30 General.
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.310 General.
.311 Most frequently observed.
.3110 General.
.3111 Anthrax.
.3112 Caseous lymphadenitis.
.3113 Hemorrhagic septicemia.
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.3119 Miscellaneous.
.312 Less frequently observed.
.3120 General.
.3121 Blackleg.
.3122 Foot-and-mouth disease.
.3123 Infectious abortion.
.3124 Lip and leg ulceration.
.3125 Lump jaw.
.3126 Rabies.
.3127 White scours of lambs.
.3129 Miscellaneous.
.319 Miscellaneous.
.32 Nontransmissible diseases.
.320 General.
.321 Garget.
.322 Gas gangrene.
.323 Goiter.
.324 Milk fever.
.325 Pneumonia, pleurisy.
.326 Tetanus.
.329 Miscellaneous.
.33 Parasites and parasitic diseases.
.330 General.
.331 Grub in head.
.332 Liver fluke.
.333 Lungworm.
.334 Maggots.
.335 Scabies.
.336 Screw worm.
.337 Stomach worm.
.338 Ticks.
.339 Miscellaneous.
.3391 Bladder worm.
.3392 Hookworm.
.3393 Lice.
.3394 Nodular worm.
.3395 Tapeworm.
.34 Other abnormal conditions.
.340 General.
.341 Bloat.
.342 Difficult parturition.
.343 Foot rot.
.344 Gravel.
.345 Rickets.
.349 Miscellaneous.
.39 Miscellaneous.
.4 Hogs.
.40 General.
.41 Transmissible diseases.
.410 General.
.411 Most frequently observed.
.4110 General.
.4111 Flu.
.4112 Hemorrhagic septicemia.
.4113 Hog cholera.
.4114 Necrobacillosis.

.4 Hogs—Continued.
  .41 Transmissible diseases—Continued.
    .411 Most frequently observed—Continued.
      .4115 Swine plague.
      .4116 Tuberculosis.
      .4119 Miscellaneous.
    .412 Less frequently observed.
      .4120 General.
      .4121 Anthrax.
      .4122 Erysipelas.
      .4123 Foot-and-mouth disease.
      .4124 Infectious abortion.
      .4129 Miscellaneous.
    .419 Miscellaneous.
  .42 Nontransmissible diseases.
    .420 General.
    .421 Cannibalism.
    .422 Eczema.
    .423 Ergotism.
    .424 Garget.
    .425 Pneumonia, pleurisy.
    .426 Posterior paralysis.
    .427 Rheumatism.
    .428 Rickets.
    .429 Miscellaneous.
      .4291 Tetanus.
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    .431 Kidney worm.
    .432 Lice.
    .433 Lungworm.
    .434 Mange.
    .435 Roundworm.
    .439 Miscellaneous.
  .44 Other abnormal conditions.
    .440 General.
    .441 Abscess.
    .442 Choke.
    .443 Fracture.
    .444 Hairlessness of pigs.
    .445 Heat stroke.
    .446 Hernia.
    .447 Poisoning.
    .448 Thumps.
    .449 Miscellaneous.
  .49 Miscellaneous.
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  .50 General.
  .51 Transmissible diseases.
    .510 General.
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      .5110 General.
      .5111 Chicken pox.
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    .519 Miscellaneous.

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  - .521 Gout.
  - .522 Limberneck.
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- .53 Parasites and parasitic diseases.
  - .530 General.
  - .531 Gapes.
  - .532 Lice.
  - .533 Mites.
  - .534 Roundworm.
  - .535 Scabies.
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ANIMAL DISEASES, PARASITES, AND OTHER ABNORMAL CONDITIONS

GENERAL

The prevention of disease depends largely upon the proper care and management of livestock by the farmer and stockman, but when disease is present a competent veterinarian should be consulted. Skillful diagnosis and the administration of potent and dangerous drugs require training and experience.

County extension agents can render valuable service in the following manner: (1) Advise farmers and stockmen in regard to measures necessary to prevent the introduction of infection and to restrict the spread of disease; (2) report centers of infection to the proper authorities; (3) cooperate with organizations, practicing veterinarians, and State and Federal officials in dealing with the suppression of disease outbreaks.

HORSES, MULES, AND ASSES

Transmissible Diseases Most Frequently Observed

Anthrax (Charbon)—*Description.*—Severe and usually fatal contagious disease to which practically all animals, including man, are susceptible. Most prevalent in low, moist lands during warm weather. Symptoms develop rapidly and consist of great depressions, chills, muscular weakness, high temperature, fast breathing, and rapid heart action. After death decomposition is rapid, and body openings exude a bloody foam.

Control.—Medicinal treatment is not satisfactory, although the use of serum often gives good results. Prevention consists in keeping animals from known infected areas, the destruction of animals dead from the disease by complete burning, and by the use of immunizing vaccine. Never skin or cut open the body of an animal dead from the disease. Burn all body discharges, and disinfect contaminated premises. Report outbreaks to livestock sanitary officials.

Distemper (Strangles)—*Description.*—Infectious disease most frequently observed in immature horses, mules, and asses. One attack usually gives permanent immunity. Begins with a fever and most often associated with an abscess formation under the jaw. Coughing and abundant nasal discharge are common symptoms. Most cases recover if proper hygienic treatment is given; however, such sequelæ as bronchitis and pneumonia may complicate conditions.

Control.—Separate healthy from infected animals, and disinfect stables where disease has occurred. Ordinary cases seldom require more than good care, such as protection against cold, giving of nourishing feed, and a mild laxative. Avoid infected premises such as public stables. A vaccine with curative and protective power is now procurable for the treatment of and immunization against this disease.

Infectious Abortion—*Description.*—Expulsion of a dead fetus or of one so immature that life is impossible is termed abortion. A large majority of abortions is caused by infection. This form is highly contagious and occa-

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sions great economic loss. It is rather prevalent on horse-breeding farms. When abortions occur without known cause, infection should be suspected.

Control.—Isolate aborting animals. Burn or bury the fetus, membrane, and all discharges, and disinfect premises. Inject mild antiseptic douches into the vagina periodically, and do not rebreed for several months after all discharge ceases. Advice and services of an expert veterinarian are essential where valuable animals are involved.

Influenza (Pink Eye)—*Description.*—Serious disease chiefly on account of its numerous complications. In the simple form it is characterized by high fever, great depression, swellings of the limbs and along the belly, and highly inflamed eyes. More frequently found in cities where numbers of horses are congregated in marketing, where it may assume epizootic proportions. One attack may reduce the susceptibility to future attacks.

Control.—Ordinary cases often respond to simple treatment, such as giving nourishing feed and taking other hygienic precautions, but on account of the frequency of complications it is advisable to obtain professional aid. Newly purchased animals should be isolated for at least a week. Avoid infected premises such as feed and sale stables.

Transmissible Diseases Less Frequently Observed

Dourine—*Description.*—Infectious disease naturally affecting only breeding horses and asses. Not widely distributed in the United States. Arizona and Montana are present centers of infection. Early symptoms appearing as irritations, swellings, and yellowish discharge are largely confined to the sexual organs. Later constitutional evidences appear. Commonly transmitted by act of copulation. Course of disease is variable; may last several months, but usually terminates fatally.

Control.—Report suspected cases to livestock sanitary authorities. State and Federal regulations provide that infected animals be destroyed and owner reimbursed.

Fistula and Poll-Evil—*Description.*—These terms apply to abscesses or ulcerous conditions, the former when located upon the withers and the latter upon the poll. They develop as the result of previous injury and are characterized by hot swelling and soreness in the early stages and later by the formation of canals to the surface, and the discharge of large quantities of pus.

Control.—Avoid the bruising or irritating of the parts by ill-fitting harness and saddles. Select animals normally developed in these parts. In early stages give a physic and apply washes or liniments. After pus develops the condition requires a surgical operation, which if delayed often results in the case running into a chronic and aggravated form. Vaccines are often used with good results.

Glanders and Farcy—*Description.*—Fatal, though often prolonged, contagious disease of horses, mules, and asses. Also communicable to man, dogs, and cats. Characterized by the formation of discharging ulcers of the nasal passages and along lymphatic chains of the skin. The term "farcy" is applied to the form showing the skin lesions. Chronic form shows distinctive starlike scars where ulcers have healed. Definitely diagnosed by laboratory examination of the blood or by the application of the Mallein test.

Control.—Attempts at treatment not advised. Avoid infected premises such as public water troughs and feed

stables. Report suspected cases to livestock sanitary authorities. State and Federal regulations require that infected animals be destroyed, and some States reimburse owners.

Moon Blindness (Periodic Ophthalmia)—*Description.*—Inflammation of the interior of the eye. Shows strong tendency to recur again and again and usually ends in blindness. Disease is associated with damp soils and wet climates. Considered hereditary by some horsemen. Affects horses of all ages, but mainly those from 2 to 6 years of age.

Control.—Treatment not satisfactory. Breed from noninfected stock. Proper feeding, housing, and management necessary. Use high land, and drain and cultivate the low lands.

Navel and Joint Ill of Foals—*Description.*—Serious infectious disease of newborn foals. Characterized by sudden, painful swellings of one or more of the joints, loss of appetite, fever, usually resulting fatally unless vigorous treatment is given. Infection gains entrance to the body through an open navel cord at the time of or soon after birth.

Control.—Provide clean stables for pregnant mares, disinfect stalls, and renew bedding frequently. Wash the navel cord of the foal with a disinfecting solution immediately after birth. Tie the cord with a sterile tape about 1½ inches from the navel, then cut the cord about 1 inch beyond. Paint the stump of the cord with tincture of iodine or a strong solution of carbolic acid. Dust daily with an antiseptic healing powder until the stump drops off.

Purpura Hemorrhagica—*Description.*—Usually occurs as a sequel to debilitating diseases, such as strangles and influenza. May arise in the absence of any disease in badly ventilated stables, among poorly fed horses, and in animals subject to exhausting work and extreme temperatures. Disease manifested by the occurrence of sudden swellings on various parts of the body, on the head or lips, limbs, or abdomen. They pit on pressure and are but slightly painful to the touch. Swellings may change location on the surface and even invade the intestinal mucous membrane.

Control.—Stimulants and tonics should be used from the start, but on account of the danger of complications it is advisable to obtain the services of a veterinarian, especially when the life of a valuable animal is at stake.

Rabies (Hydrophobia)—*Description.*—Specific communicable disease affecting all warm-blooded animals, including man. Dog is especially susceptible and because of his roving habits is the chief disseminator. In horses it develops from a few weeks to several months after the bite of a rabid animal, usually a dog. Animal shows an increased excitability and viciousness. Very slight noises or the approach of a person incite the animal to kick, strike, or bite at any object near him. Very often the horse will bite his own limbs or sides, lacerating the flesh and tearing the skin. The eyes appear staring, bloodshot; the ears are on the alert to catch all sounds; the head is held erect.

Control.—When a horse is known to have been bitten by a rabid animal, immediate cauterization of the wound with a red-hot iron may possibly destroy the virus before absorption takes place. As soon as the disease is identified as rabies the affected animal should be killed.

Swamp Fever (Infectious Anæmia)—*Description.*—Disease is most prevalent in the low-lying and poorly drained sections. Most outbreaks occur during summer and early

fall. Characterized by fever, progressive emaciation, anæmia, and listlessness, in spite of an abnormal appetite. Infection may take a chronic course, ending in death in two months to two years.

Control.—Keep animals off suspected premises. Separate healthy from the sick and disinfect infected quarters. No treatment has been satisfactory.

Nontransmissible Diseases

Azoturia (Black Water or Monday-Morning Disease)—*Description.*—Caused by heavy feeding of horses during period of idleness and manifests itself soon after they are again put to work in staggering gait, profuse sweating, dark red urine, and collapse. May end fatally in a few hours if a severe case, although many cases recover if properly handled.

Control.—Call a veterinarian, remove harness, cover animal with blanket, and keep animal quiet until professional aid is available. Prevent by feeding idle horses a light diet.

Big Leg (Lymphangitis)—*Description.*—Specific inflammation of lymphatic structures. Usually affects the hind legs. Disease is sudden in attack, exceedingly painful, accompanied by high temperature and great general disturbances. Cause often may be traced to a small wound which has become infected or to overfeeding.

Control.—Bathe parts freely and frequently with water as hot as the hand can bear it, then foment with vinegar and water, equal parts, to which add 2 ounces of nitrate of potassium for each gallon. Dry leg with woolen cloth and bathe with camphorated soap ointment. Internally administer artificial Carlsbad salts in 2 to 4 ounce doses three times daily. Feed lightly and give complete rest.

Forage Poisoning—*Description.*—Dangerous disease of the nervous system, caused by the ingestion of poisonous molds which may develop in spoiled grain, silage, vegetables, fruit, and in cornstalk fields or pasture. The symptoms are staggering gait, inability to swallow, impaired eyesight, and often, later, violent delirium ending in death.

Control.—Make a complete change of feed or remove animals from the pasture as soon as a case develops. Use of botulinus antitoxin is about the only chance to save the animal in well-developed cases.

Founder (Laminitis)—*Description.*—Inflammation of the internal tissues of the hoof, characterized by lameness, intense local heat, pain, and a tendency to deformation or loss of the hoof. Causes may be concussion, overexertion, too much heavy feed, injuries which throw additional weight on the normal feet, faulty shoeing, and excessive drinking of cold water when the animal is hot.

Control.—Treatment is varied, but use of purgatives and diuretics to increase the excretions, and in early stages the application of cold water to the hoofs, are commonly used. Remove shoes and protect animal against exposure to cold drafts.

Heaves—*Description.*—Not a disease in itself, but an outward manifestation of internal anatomical changes causing abnormal breathing. Respiration is mostly abdominal and accompanied by a peculiar grunt or cough. Cause is not definitely known, but appears to be associated with a disordered digestion. Administration of certain drugs will cover the symptoms, so care should be used when horses are bought from unreliable persons.

Control.—No permanent cure, but many affected animals remain serviceable with proper feeding and manage-

ment. Do not feed bulky or dusty feeds. Feed hay sparingly, and moisten it. Use sawdust or shavings for bedding. Water before feeding. Fowler's solution of arsenic, in 1-ounce doses in the drinking water three times daily, tends to relieve the symptoms.

Pleurisy—*Description.*—Inflammation of the membrane which lines the chest cavity and covers the lungs. Most often occurs as a complication of pneumonia and other affections of the chest organs. Usually indicated by painful breathing, suppressed coughing, pain upon pressure between the ribs, and elevated temperature.

Control.—Usually associated with other conditions requiring professional treatment. Call a veterinarian.

Pneumonia (Lung Fever)—*Description.*—Inflammation of the lungs. Frequently observed in connection with such diseases as influenza and strangles, but may develop as an independent affection from the neglect of simple colds or from foreign bodies gaining entrance into the lungs as in drenching, choke, or the inhalation of irritating gases or heavy smoke.

Control.—Avoid the causes. Provide hygienic quarters and nutritious feed. Consult a veterinarian.

Tetanus (Lockjaw)—*Description.*—Specific disease of the nervous system caused by the entrance into the body, through wounds, of a germ that is often found in manure and soil. Foot wounds are most dangerous. Characterized by a stilted gait, difficulty in chewing and swallowing, and the extension of a membrane, called the third eyelid, over the inner surface of the eye, and later a general spasmodic rigidity of all muscles. Cases with well-pronounced symptoms usually result in death.

Control.—Carefully disinfect all wounds with iodine or strong carbolic-acid solution and give drainage, especially to wounds of the foot and all puncture wounds. Tetanus antitoxin is most effective treatment, but to give good results it must be injected before symptoms are pronounced. It is expensive, but justifiable when a valuable animal is involved.

Parasites and Parasitic Diseases

Bots.—(See 8.24.)

Flies.—(See 8.24.)

Lice—*Description.*—Two kinds of lice attack the horse, one of them having a narrow head and proboscis for perforating the skin and sucking the blood, and the other, the broad-headed kind, having strong mandibles with which it bites the skin. Poor condition, itching, and loss of hair indicate the presence of lice.

Control.—Apply coal-tar creosote, nicotine, or arsenic dips. Repeat every 10 to 12 days to destroy the lice hatched from nits in the interval.

Mange—*Description.*—Affection due to the irritation of the skin caused by the presence of mites. Symptoms are incessant, intolerable, and increasing itching of some parts of the skin (head, mane, tail, and back), the horse inclining himself toward the hand that scratches him and moving his lips as if himself scratching. The skin becomes scabby and sometimes thickened. Hair may be broken and rubbed off, but the part is never entirely bald as in ringworm. Rubbing may give rise to sores.

Control.—Remove the scabs with soapsuds, and if necessary, with a brush. Apply tobacco 1½ ounces, and water 2 pints, prepared by boiling. Use more than once, if necessary, and repeat in 10 to 14 days. Similarly treat harness and stable utensils, boil blankets and rubbers, and whitewash the stables, using one-fourth pound of chloride

of lime to the gallon. Dipping is always preferable to hand applications. Use nicotine, lime-sulphur, or arsenical dips.

Pinworms—*Description.*—Parasite of the large intestines, rather commonly found in horses in the United States, but does little damage unless present in large numbers. The worms in the adult stage are several inches in length and often have a long tail. Infested animals may show a tendency to tail rubbing on account of the irritation caused by the parasites.

Control.—Injection of an enema made of an infusion of quasia chips, one-half pound to the gallon of water, into the rectum once or twice a day is an aid to control. Four to five drams of oil of chenopodium, accompanied by a quart of raw linseed oil, or an aloes or aloin ball by mouth, will remove the worms. It is advisable to have this treatment given by a veterinarian.

Roundworm—*Description.*—Large intestinal worm about the size of a lead pencil. Seldom causes much harm.

Control.—If suspected in cases of general unthriftiness, call a veterinarian.

Other Abnormal Conditions

Colic—*Description.*—Term loosely applied to all disorders of the organs of the abdomen that are accompanied by pain. Not a disease, but may be a symptom of a variety of conditions. The more common manifestations are restlessness, lying down, turning head toward the flank, pawing, switching the tail, stretching as though to urinate, and sweating. Usually the pain is not constant, and during intervals animal may appear normal.

Control.—Prevention by proper feeding is important. Avoid irregular feeding and such feeds as green oats and other improperly cured grains. Avoid feeding grain when animal is tired and hot. In mild cases give raw linseed oil as a drench. In severe cases call a veterinarian.

Curb—*Description.*—Term applied to the condition manifested by a bulging backward of the posterior part of the hock. May be caused by a strain, extreme effort in heavy pulling, high jumping, slipping, or a congenital weakness. Lameness usually is evident.

Control.—Make cold applications in early stages. Later blistering ointments may be required and frequently "firing" by the use of a hot iron in the hands of an expert.

Thoroughpin (Bog and Blood Spavin)—*Description.*—Term applied to different enlargements of the joint sac, blood vessels, and other soft tissues about the hock joint. Common cause is overexertion of the parts. Usually no lameness.

Control.—Give the animal rest. Liniments, blisters, and sometimes cauterization are used in attempts to relieve the condition.

Spavin (Bone Spavin)—*Description.*—Bony malformation of the hock joint usually associated with enlargement. Immediate cause is an inflammation of membrane which covers the bone and from which the bone grows. A sprain is usually an exciting cause. A tendency to spavin seems to be inherited in some instances. A peculiar lameness, which may be constant, is a common symptom.

Control.—No known treatment will remove the bony enlargement. However, the symptoms may be abated by resting the animal, the application of blisters, and in extreme cases cauterization with a hot iron in the hands of an expert.

Difficult Parturition—*Description.*—Such a condition is rare in the mare when there is natural presentation of the fetus. May be caused by a naturally narrow pelvis, one distorted by previous fracture, hernia, or fecal impaction of the rectum.

Control.—Services of a veterinarian are needed in difficult cases.

Galls, Corns, Boils—*Description.*—Terms applied to various enlargements resulting from friction and pressure. When caused by ill-fitting harness or saddles, the term galls or "sitfast" is used; when on the sole of the foot, corns; and when in other locations, boils.

Control.—Use proper equipment when working or riding animal. Use judgment in exercising young stock, and all stock after a long period of idleness. See that the shoes fit properly and avoid rough riding. Galls may require surgical removal. Corns may also require surgery. Keep boils drained and washed with antiseptic solution until healing starts.

Heat stroke—*Description.*—Caused by excessive work in great heat, especially if horse is not used to it or has had a previous attack of the ailment. Animal suddenly lags, hangs its head, staggers, and falls, does not sweat, breathes rapidly, pulse very fast, and temperature greatly elevated.

Control.—Exercise care in working the horses, particularly during the first few hot days of the season. Release the check rein in hot weather. In treating heat stroke, apply ice or cold water to head and body. Give rectal injections of cold water. A veterinarian may be needed to give spirits of niter or aromatic spirits of ammonia to support the heart. Give water frequently and good feed regularly.

Knuckling—*Description.*—Term applied to a partial dislocation of the fetlock joint, which permits the angle of the joint to disappear or to be reversed. Affects the gait, resulting in knuckling or stumbling. May be caused by overwork, working at too young an age, faulty conformation from birth, or disease.

Control.—In young colts, if no deformity exists, recovery will take place naturally. In older animals, rest and special shoeing may help. Surgical attention is sometimes necessary.

Interfering—*Description.*—Term applied to self-inflicted injuries to the inside of the fetlock. Caused by the hoof or shoe of the opposite foot, usually on account of faulty conformation, too fast gaits, or improper shoeing.

Control.—Remove the cause, and treat as a simple wound.

Stringhalt—*Description.*—Term applied to an involuntary movement of one or both hind legs, in which the foot is suddenly and spasmodically lifted higher than normally during locomotion. All ages are affected. Condition may become lessened with exercise and usually is first detected when the animal is backed from the stall. Exact cause is unknown.

Control.—If no lesion is apparent, an operation by a competent veterinarian may correct the trouble.

Ringbone—*Description.*—Term applied to a bony growth just above the hoof. Result of an inflammation of the bone of the region. May be caused by bruises, blows, sprains, or other violence. Tendency to development may be hereditary. Lameness noticeable, as a rule, partially disappearing with exercise but returning afterwards.

Control.—Avoid the causes, and do not breed from stock habitually predisposed to the condition. Blistering ointments and cauterization recommended in pronounced cases. Special shoeing tends to relieve the condition, and severing of the sensory nerve is sometimes advisable.

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Sidebone—*Description.*—Lateral cartilages of the hoof, which extend around to the heel, lose their elasticity and become hard and bony. Usually noticed in the front feet with characteristic lameness.

Control.—Paint region with tincture of iodine, or use blisters. If this is not effective, place the case in the hands of a veterinarian.

Splint—*Description.*—Bony enlargement that occurs usually on the inside of the cannon bone between the knee or hock and the fetlock. Size varies, but enlargement usually is perceptible to the eye or touch. Lameness may or may not be a symptom. The condition is common, especially in the animal that is used on hard surfaces or city streets.

Control.—Avoid attempts at treatment unless lameness is present. In persistent cases resort to blistering or surgical treatment.

Scratches (Cracked Heels)—*Description.*—A condition characterized in early stages by swelling, heat, and tenderness of the hollow of the heel, stiffness and lameness, followed by transverse cracks, which may exude pus, but more frequently firm, dry scabs form from the liquids thrown off. Some horses of heavy lymphatic nature seem predisposed to it. Caused by overfeeding of grain, constant contact of parts with dung, urine, deep mud, or other irritants, such as lime dust or sand, use of caustic washes, clipping the heels, and sometimes as a sequel to debilitating diseases.

Control.—Avoid conditions favorable to its development. Remove the cause and give a mixed laxative or tonic. Sugar of lead and glycerin washes may be used.

Grease Heel (Canker)—*Description.*—Specific fungous affection of the heel, usually associated with an offensive discharge and the formation of red, raw growths resembling grapes. Causes similar to those given under scratches, but disease is aggravated by the presence of the specific causative agent.

Control.—Sanitary measures are important. Keep stables well ventilated and free from filth. Give nourishing diet and regular exercise, and avoid local irritants. Benzoated oxide-of-zinc ointment may be used at the outset. A still better dressing is made with 1 ounce vaseline, 2 drams oxide of zinc, and 20 drops iodized phenol. If the surface is much swollen and tender, a flaxseed poultice may be applied, over the surface of which has been poured some of the following lotion: Sugar of lead, one-half ounce; carbolic acid, 1 dram; water, 1 quart. To destroy the "grapes," rub them daily with strong caustics (copperas, bluestone, or lunar caustic).

Thrush—*Description.*—Characterized by an excessive secretion of unhealthy matter from the cleft of the frog of the hoof. Most often observed in the common type of draft horse, because of conditions under which it is used. Filthy stables and excessive moisture are the most common causes. Lameness is present only in extreme cases.

Control.—Avoid predisposing conditions. Remove the cause, and practice cleanliness. In obstinate cases, poulticing of the foot, followed by use of disinfecting washes, may be necessary.

Choke—*Description.*—Rather common condition, usually resulting from attempts to swallow solid fruits or roots. Also occurs in some greedy horses while they are eating oats from deep feed boxes. Animal shows distress and violent coughing.

Control.—Remove the obstruction by way of the mouth if possible. The use of a mouth speculum will facilitate

the work. If this fails force the obstruction downward by means of a probang. This is attended with considerable danger to the animal. In the absence of a regular instrument, a piece of smooth, clean garden hose, previously greased with tallow, may be introduced into the gullet, the mouth being kept open by a gag. If all these fail, the removal by a surgical incision or the administration of drugs that increase secretions, will be necessary. In severe cases, involving valuable animals, the services of a competent veterinarian should be obtained.

Dislocations—*Description.*—Characterized by the displacement of the joint surfaces of the bones. Less frequently observed among lower animals than in man, and in large animals than small. The condition manifests itself by alteration in shape of the joint, in length of the limb, and in the movableness of the parts, usually an unnatural immobility. In the horse the condition is most often observed in the shoulder, hip, and patella joints.

Control.—Treatment consists of replacement of the parts and their retention until repair is effected. The services of a veterinarian are usually necessary.

Enamel Points—*Description.*—Characterized by the irregularities that often occur on the wearing surfaces of the jaw teeth. The upper jaw being wider than the lower causes the outer edges of the upper and the inner edges of the lower teeth to develop ridges. This condition sometimes interferes with proper mastication.

Control.—Use a rasp or float to file off the projections. The use of a mouth speculum will facilitate the operation. Attention is rarely necessary.

Lampas—*Description.*—Characterized by a swelling of the mucous membrane covering the hard palate immediately behind the upper front teeth and occurs normally to some extent during mastication in the healthy horse. May become aggravated when there is unusual irritation of the mouth such as during teething or in simple sore mouth.

Control.—The barbarous practice of applying a hot iron to the affected parts is condemned. Removal of the cause and the use of astringent washes will bring relief in most instances.

Fracture—*Description.*—Term is applied to the breaking, complete or partial, of the bone. It is always a serious lesion in the horse. However, the location of the break and its severity will have much to do with the outcome.

Control.—The services of a veterinarian are required. In many such instances the usefulness of the animal may be preserved by the application of modern methods, as compared with the old-fashioned idea that a fracture of a limb was a death warrant to the animal.

Nail Prick—*Description.*—Characterized as puncture wounds of the hoof. It is indicated by lameness, depending upon the severity of the injury. Should be given attention at once, since tetanus germs enter the body by such wounds. Sometimes occurs in shoeing by the nails being directed improperly.

Control.—Remove boards with protruding nails or other dangerous substances that lie about where horses may step on them. Use care in shoeing. Open the wound, and let it drain. Inject tincture of iodine. If wound is deep, poulticing may be necessary. Keep the parts clean and the animal out of manure or other foul footing.

Quittor—*Description.*—Term is applied to various affections of the foot wherein the diseased tissues undergo a degeneration and the elimination of the products by sloughing. Characterized by evidences of extreme pain

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and swelling immediately over the hoof, which breaks and discharges pus. Corns and bruises of the foot, particularly of the coronet as by tramping calk wounds, or overreaching, are most often responsible.

Control.—Treatment consists in the use of antiseptics, poultices, and sometimes a surgical operation.

Roaring—*Description.*—Condition caused by chronic diseases in which an unnatural loud noise is associated with breathing. Peculiar roaring sound is more noticeable during inspiration. The true chronic form is caused by paralysis of the muscles of the larynx.

Control.—An operation for removal of the paralyzed portions of the larynx is believed to be the only relief for the chronic form.

Sand Crack—*Description.*—Fissure in the horn of the wall of the foot. Most frequently observed in front on the hind foot and on the sides of the fore foot. Often caused by the hoof becoming too dry. Is associated with heavy use on hard surfaces. Not a serious condition, as interference with use is rare, except in extreme cases, when lameness may be evident.

Control.—Avoid the causes, and keep the hoofs in good condition by using an ointment. Earth floors in the stables will help. May be necessary to place mechanical clasps over the fissure.

Sweeny—*Description.*—This is not a disease, but merely the wasting away of muscles because of lack of use, such as from injuries interfering with normal activity of limbs or muscles.

Control.—Parts may return to normal after removal of the cause, but artificial stimulation by use of irritants may be necessary.

CATTLE

Transmissible Diseases Most Frequently Observed

Anthrax.—(See .1111.)

Blackleg (Black Quarter)—*Description.*—Rapidly fatal infectious disease of young cattle, especially associated with external swellings, which emit a crackling sound when handled. Most cases are observed in animals between the ages of 6 and 30 months. More or less restricted to certain localities, the causative germ being present in the soil.

Control.—Treatment of infected animals is practically useless. Prevention by the use of immunizing vaccines and filtrates is very effective and is advised where there is history of a previous outbreak. If the disease occurs, remove all well animals from the infected pasture, and vaccinate before exposing them again. Carcasses of animals that die from the disease should be buried and anything contaminated by them thoroughly disinfected.

Cowpox—*Description.*—Contagious disease of cattle, manifested by an elevated temperature, shrinkage in milk production, and the appearance of characteristic pustular eruptions, especially upon the teats and udders of the dairy cows. Usually transmitted from cow to cow by an attendant, such as a milker, and as a rule passes through the entire herd.

Control.—Apply carbolized vaseline or iodoform ointment to affected parts. Observe cleanliness, and milk noninfected cows first. Disinfect hands and utensils.

Hemorrhagic Septicemia (Shipping Fever)—*Description.*—Highly fatal infectious disease affecting several species of domestic and wild animals. It is a septicemia (blood poison) and most often develops after animals have been exposed as in shipping, or their resistance lowered by poor feeding. Disease is accompanied by loss of appetite and usually high fever. Death often follows in six to eight hours.

Control.—Medicinal treatment is quite useless. Sanitary precautions, such as isolation, disinfection, and burial or burning of animals dying from the disease should be observed. Preventive vaccination as a protection to exposed animals or before shipping has given good results.

Infectious Abortion.—(See .1113.)

Pink Eye—*Description.*—Contagious eye disease of cattle, usually introduced into a herd by newly purchased animals. Most often occurs during summer and affects all ages. Characterized by profuse eye discharge which may be mixed with pus or blood. Affected animals keep eyes closed and show symptoms of general illness, such as fever and decreased appetite. Aggravated cases may cause loss of the eye. The course of the disease is about 10 days.

Control.—Place affected animals in a cool, dark shelter, and supply with good water and succulent feed. Keep them out of the bright sunlight, and use a solution of boric acid or common salt as an eye wash. In obstinate cases a 10 per cent solution of argyrol is advised. Remove susceptible animals from infected pastures.

Tuberculosis—*Description.*—One of the most serious of our cattle diseases, also affecting hogs and poultry, is caused by the tubercle bacillus. Most cases, especially

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in early stages, show no outward symptoms. Later, there may be emaciation, chronic diarrhea, coughing, and rough-hair coat.

Control.—Best-known method of detection is the tuberculin test. This consists of the injection of a biological product known as tuberculin under the skin (subcutaneous), in the layers of the skin (intradermic), or in the eye (ophthalmic), and careful observation of the reaction. The general eradication by the tuberculin test, as a diagnostic agency, the slaughter of reacting animals, and the disinfection of premises and quarantining, is being conducted by the United States Department of Agriculture in cooperation with local authorities and cattle owners. The two main projects are the accredited-herd plan and the area-eradication plan. The former deals principally with individual herd testing, and the latter has to do with the testing of all bovine animals within a civil district, such as a county or township. When tuberculosis is suspected in a herd, or there is interest in taking up the work, communicate with the State livestock sanitary authorities, or the Bureau of Animal Industry, Washington, D. C.

Transmissible Diseases Less Frequently Observed

Foot-and-Mouth Disease—*Description.*—Highly communicable disease chiefly affecting cloven-footed animals. Characterized by eruption of blisters of the mouth and between the toes and just above the hoofs. The disease has made its appearance in the United States on eight different occasions, namely, 1870, 1880, 1884, 1902, 1908, 1914, and twice in 1924. In each case it has been eradicated. It is common in most countries of the eastern hemisphere and in South America. In its later stages it may be confused with ordinary sore mouth, which is a different condition.

Control.—Vigorous measures, including the slaughter of the infected and exposed animals, as well as strict quarantine, have been used in eradicating the various outbreaks in the United States. Suspected cases should be reported to livestock sanitary officials.

Johne's Disease—*Description.*—Affects cattle and in rare instances sheep and goats. Chronic disease caused by a specific germ, which grows in the intestinal walls and adjacent lymph glands. Diarrhea is usually the first symptom, which disappears only to reappear at intervals for months and sometimes years. Animal becomes gradually thinner until almost a skeleton. Disease usually fatal.

Control.—May be confused with tuberculosis, but infected animals do not react to the tuberculin test. No satisfactory treatment. Obtain the services of a veterinarian to make a diagnosis. Avoid bringing in cattle from affected herds. Do not let the feed become contaminated with feces from diseased animals.

Lump Jaw—*Description.*—Chronic infectious disease characterized by the formation of peculiar tumors or swellings on the side of the face or jaw. Not directly transmitted from one animal to another, but the causative agent (a fungus found growing on grasses, barley, oats, and other grains) is carried with feed to find lodgment in the membranes of the mouth or between the teeth where it develops and causes the well-known lesions. May cause lesions in the respiratory organs. Human beings are susceptible.

Control.—The administration of iodide of potassium has given satisfactory results, but should not be at-

tempted in pregnant animals or cows in milk. Surgical removal of the tumors by trained surgeons followed by medicinal treatment is advised in such cases. Unless the affected animals are especially valuable slaughter may be the best procedure.

Rabies (Hydrophobia)—*Description.*—Manifests itself in a furious as well as a dumb form, the former being the most common. Development follows the bite of a rabid (mad) animal, the period of incubation depending upon the nearness of the bite to the central nervous system and the depth of the wound. Affected cattle show signs of restlessness, loud roaring with a peculiar change in the voice, pawing, and butting. This is followed about the fourth day by the paralytic stage and death. Inability to swallow is usual, although the jaw is not set as in lockjaw.

Control.—Treatment is useless. Control the stray dogs. Confine all sick and exposed animals until they are released by livestock sanitary officials.

Sore Mouth—*Description.*—Mycotic stomatitis refers to that form of the sore mouth which results from eating food contaminated with the causative fungi and is noncontagious. Necrotic stomatitis, usually seen in cows, is caused by the filth germ, is highly contagious, and without treatment is fatal. These two diseases should not be confused with foot-and-mouth disease.

Control.—Keep animals from sources of infection. Isolate infected animals. Use cleansing and antiseptic agents such as permanganate of potash or boric acid on the affected parts.

Tick Fever (Texas Fever)—*Description.*—Specific disease of cattle caused by protozoa, which are conveyed to affected animals only by the bite of the fever tick. Characterized by high fever, reddish urine, rapid emaciation, and high mortality.

Control.—Keep susceptible cattle away from the ticks. Remove both sick and well cattle to noninfected premises after removal of the ticks by dipping or other means. Medicinal treatment has not proved very satisfactory.

White Scours of Calves—*Description.*—Characterized by a violent and deadly form of diarrhea appearing soon after birth. Bowel discharges are profuse, yellowish white, and have a very offensive odor. Death usually occurs in 24 to 36 hours. On infected premises practically every calf dropped develops the disease year after year, unless vigorous sanitary measures are used.

Control.—Treatment is of no avail. Clean and disinfect the stables and utensils. Provide separate and sanitary stalls and equipment for calving time. Tie off and disinfect the navel of the calf immediately after birth. Wash parts with a strong antiseptic solution.

Nontransmissible Diseases

Ergotism—*Description.*—Disease caused by the ingestion of ergot, a plant fungus which often grows on the seed of rye, blue grass, redtop, oats, and other grasses and grains. Cattle appear to be more susceptible than other animals. Disease acts in producing a mummification or dry gangrene of the extremities, such as the ears, tail, and feet, causing the parts to dry up and drop off. Pregnant animals may abort.

Control.—Treatment is not very satisfactory, but change of feed and use of local antiseptics are advised. To prevent avoid feeding of ergotized material.

Garget (Inflammation of the Udder)—*Description.*—Conditions may arise from a number of causes, such as trau-

matic injuries, exposure, overfeeding, especially with rich feeds, or failure to draw the milk completely, particularly in heavy-milking cows at the height of lactation. It is indicated by a hot, sensitive, and swollen udder, elevated temperature, fast pulse, excited breathing, and decreased milk flow. Trouble may pass quickly if proper hygienic measures are employed or may go into a serious condition, if in aggravated form or if neglected.

Control.—Affected animal should be protected from exposure and given access to pure water and comfortable quarters. Bathe the udder with hot-water fomentations, dry thoroughly, and apply camphorated ointment by careful massaging. If this treatment does not give relief, a veterinarian should be called.

Milk Fever—*Description.*—Serious disease of cows, occurring at or near the time of calving. Heavy milkers, in good condition, are most often affected. Characterized by a more or less sudden loss of voluntary movement and sensation, and animal falling and being unable to rise. Often the head is turned to rest on the right flank. If relief is not given promptly, death usually follows rather quickly.

Control.—Prevention consists of light feeding and ample exercise of plethoric, heavy-milking cows for a few days before and after calving. Cases respond quickly to the distention of the udder with oxygen or filtered air, by injection with a pump by way of the teats. Extreme care must be used in this process on account of the danger of introducing infection into the udder. Never attempt to drench a cow having this disease, as the throat is usually paralyzed and the medicine goes into the lungs, causing pneumonia.

Pica (Depraved Appetite)—*Description.*—Indicated by a strong desire to lick and eat substances for which healthy cattle show no inclination. Probably caused by the insufficiency of necessary elements, such as lime, in the feed. Most often observed in regions of sparse vegetation as on some western ranges or low, swampy lands.

Control.—Remove the affected animals from the old area and feed a nutritious ration, especially one strong in minerals. Give access to salt, preferably in rock form. The following mineral mixture may be given in daily doses of a heaping tablespoonful: Carbonate of iron, 4 ounces; finely ground bone (bone flour) 1 pound; powdered gentian, 4 ounces; common salt, 8 ounces; and powdered fenugreek, 4 ounces.

Pleurisy.—(See .126.)

Pneumonia.—(See .127.)

Parasites and Parasitic Diseases

Flies.—(Horn fly and stable fly. See 8.22.)

Lice.—(Biting louse and sucking louse. See 8.22.)

Lungworm—*Description.*—Threadlike worm from 2 to 4 inches in length found in the bronchial tubes and causing a form of bronchitis. Infestation is evidently through the medium of infected pastures. Young cattle, especially those poorly nourished, most often develop the disease. Coughing, especially at night, is a common symptom, particularly in late stages. A disorder is usually present.

Control.—Affected animals should be removed to safe, dry, uninfected quarters, where wholesome food and water are available. A salt supply should be handy. Medicinal treatment is more or less futile. With proper nursing, animals usually recover.

Mange, Scab, Itch—*Description.*—Cattle are subject to four kinds of mange, namely, psoroptic, chorioptic, sar-

coptic, and demodecic. Psoroptic mange is caused by small mites spread by infected animals, pens, stables, or railroad cars. Attacks skin and causes it to become thickened and covered with crusts and scabs, with a consequent loss of hair. Commences at the root of the tail, on the neck or withers, and gradually extends over the back up to the head, over the sides, and may finally affect nearly the entire body except the legs. Chorioptic mange, due to a different species of mite, is confined almost entirely to the region at the root of the tail, and if not treated may persist for years. Sarcoptic mange, frequently called "barn itch," affects the head and neck and also may occur in other parts of the body. Demodecic mange is caused by a small parasite that lives in the hair follicles, causing pustules on neck and shoulders. No practicable treatment known for this last disease.

Control.—For psoroptic mange dip animals in a vat filled with a liquid of such nature that it will kill the parasites without injuring the cattle. The lime-sulphur dip is made in the proportion of 12 pounds of unslaked lime (or 16 pounds of commercial hydrated lime—not air-slaked lime), and 24 pounds of flowers of sulphur, to 100 gallons of water. The nicotine dip is made with sufficient extract of tobacco, or nicotine solution, to give a mixture containing not less than five one-hundredths of 1 per cent nicotine and 2 per cent flowers of sulphur. Sufficient nicotine would therefore be furnished for 96 gallons (about 800 pounds) of dip by 1 pound of a 40 per cent solution of nicotine. Formula: Nicotine, 0.4 pound; flowers of sulphur, 16 pounds; water, 96 gallons.

Ringworm—*Description.*—Affection of skin caused by a vegetable parasite, highly contagious, forming circular patches on the skin which soon become denuded of hair. Attended with more or less itching. Communicable to man.

Control.—Remove all crusts by washing with soap and water. Apply acetic acid, sulphur ointment, tincture of iodine, or nitrate of mercury ointment once a day. Cleanse the stable, and whitewash it to destroy the spores scattered by the crusts.

Roundworm—*Description.*—Measures 6 to 12 inches in length. Sometimes found in the intestines of cattle, especially calves. May cause inflammation and occasionally rupture of the intestine. Infection occurs through swallowing of the eggs of the parasite in feed or water that has been contaminated with the feces of infested cattle. May be a cause of serious trouble in calves.

Control.—Medicinal treatment not very satisfactory. Preventive measures are important. Call a veterinarian.

Stomach worm—*Description.*—The twisted stomach worm is sometimes found in enormous numbers in the fourth stomach of cattle. Symptoms are anæmia, loss of flesh, general weakness, dullness, capricious appetite, excessive thirst, and diarrhea. Cattle become infested by grazing on pastures on which infested cattle, sheep, or goats have grazed and scattered their droppings.

Control.—Preventive measures are important. Dose the animals, both well and infested, and remove them to fresh pasture after treatment. Deprive animals of feed for 16 to 24 hours. If bluestone treatment is used animals should receive no water on the day they are dosed until several hours after being dosed. For drenching, a long-necked bottle or a drenching tube may be used. Bluestone solution prepared as follows: Take 1 pound (avoirdupois) of pure bluestone (copper sulphate), pow-

der it fine, and dissolve in 9½ gallons of water. It is better first to dissolve the bluestone in 2 or 3 quarts of water, then to add the remaining quantity of cold water and to mix thoroughly. This solution may be given to cattle in the following-sized doses:

Calves	3½ to 4 fluid ounces.
Yearlings	6 fluid ounces.
Two-year-olds and over	12 to 16 fluid ounces.

Warbles.—(Grub or heel fly. See 8.22.)

Screw Worm.—(See 8.22.)

Ticks.—(Texas fever, spinose ear tick. See 8.22.)

Other Abnormal Conditions

Bloat (Tympanites)—*Description.*—Condition caused by the rapid fermentation in the digestive organs of such feeds as clover, alfalfa, frozen roots, or decayed vegetables. The paunch fills with gas, causing a marked swelling high up in the left flank accompanied by difficult breathing and distress. Death may occur soon if relief is not given.

Control—Gradually accustom cattle to green feed. Turn them on first in the middle of the day after other feeding. Avoid decayed or frozen food of any kind. Provide an artificial outlet for gas by means of trocar and cannula inserted through the left flank into the paunch. Exercising the animal may give relief, especially if a rope, coated with pine tar, is placed in the animal's mouth as a bit. Aromatic spirits of ammonia and similar drugs given internally are often effective in less acute cases.

Casting the Withers (Eversion of the Womb)—*Description.*—Protrusion of the womb from the vagina. Occurs as a result of the failure of this organ to contract after calving. Seriousness depends upon the completeness of the eversion, the length of time it has existed, and the degree of contamination.

Control.—Carefully cleanse the protruding parts with warm water into which some common salt has been added, and by manipulation replace to their normal position. Place the cow in a stall the back part of which is higher than the front, and arrange a rope or other mechanical appliance across the vagina until contraction takes place, to prevent recurrence. Obstinate cases require the services of an expert surgeon. It is usually advisable to discard for breeding purposes a cow that has once shown this trouble.

Constipation—*Description.*—Condition to be regarded more as a symptom of a disorder than a disease. Usually present in fevers and may be caused by faulty feeding. Animal shows stoppage of the bowels, straining, colicky pains, loss of appetite, and sluggishness.

Control.—Give plenty of water. Feed less dry, bulky feed. Administer 1 pound of Glauber salt. To calves give 2 tablespoonfuls of castor oil and rectal injection of warm, soapy water.

Diarrhea—*Description.*—In simple form caused by irritation of the intestines from improper feeding, frozen roots, poisons, infectious germs, or chilling. Animal has frequent bowel passages of bad odor and thin consistency. If condition is allowed to continue the animal becomes thin and dull.

Control.—Remove the cause. For mature animal give 1 pound of Glauber salt. Give calves 1 to 2 ounces of castor oil in one-half pint of warm milk. Cut down the quantity of feed and provide comfortable surroundings.

Foul of the Foot (Foot Rot)—*Description.*—Inflammation of the foot between the toes. Usually caused by the

irritation of filth. Lameness is a symptom, as well as heat and swelling above the hoof, foul odor, and pus accumulations beneath the horn.

Control.—Keep the feet clean and provide exercise. Soak feet in a 2 per cent coal-tar disinfectant. If pus is detected beneath the horn, trim away the overlying horn to allow drainage. In more severe cases it may be necessary to bind a wad of oakum or cotton, soaked in a disinfectant, such as tincture of iodine or cresol, between the toes.

Fractures—*Description.*—A complete or partial breaking of the bone. May be due to a kick by another animal, a fall, or other traumatic injury.

Control.—Chances of recovery are fair if the animal is young, of quiet temperament, and the fracture is not too great in extent. If animal is of little value, irritable, old, and the fracture is serious, slaughter is advised. In any event, recovery is a matter of weeks or months, and requires close attention. The use of splints and slings usually is necessary.

Poisoning—*Description.*—This condition is not common in cattle except when caused by poisonous plants or where the animals gain access to such substances as lead, arsenic, or paint. Symptom: Sudden disorder without visible cause.

Control.—Give a purge composed of castor oil in 1-pint to 2-quart doses. In order to protect the lining membranes of the digestive tract from the irritating effects of poison, administer flaxseed tea, barley water, whites of eggs, milk, butter, olive oil, or fresh lard. Chemical antidotes may be used with success if the exact nature of the toxic agent is known.

Retained Afterbirth—*Description.*—May follow abortion or it may occur as a result of weakness due to improper feeding and care. Characterized by a foul-smelling discharge with fragments of membranes protruding from the vagina. Unless relief is given fever, loss of appetite, suppression of the milk flow, and rapid emaciation may follow.

Control.—If afterbirth has not passed in 48 hours after calving, call a skilled veterinarian to remove it and to prescribe after treatment.

Teat Obstruction—*Description.*—Injuries to teats may be caused by warty growths or constrictions. Teat canal becomes constricted, and the growth blocks the milk flow and makes milking difficult or impossible.

Control.—Call a veterinarian to operate and relieve the condition. A teat plug adjusted to press on the growth may be used if the obstruction is near the end of the teat. The use of a milk tube may afford temporary relief. Observe sanitary precautions when inserting the tube.

Warts—*Description.*—Warts may be classed as a nuisance, but their presence does not interfere with the animal's health. They may appear anywhere on the body, especially on the teats.

Control.—Cut off slender warts with the scissors, observing sanitary precautions. Others will usually disappear if tincture of iodine, glycerin, or glacial acetic acid is applied to their surfaces daily.

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Control.—Keep the feet clean and provide exercise. Soak feet in [illegible] or coal-tar disinfectant. If pus is detected beneath the horn, trim away the overlying horn to allow drainage. In more severe cases it may be necessary to bind a wad of oakum or cotton, soaked in a disinfectant, such as tincture of iodine or cresol, between the toes.

Fractures—Description.—A complete or partial breaking of the bone. May be due to a kick by another animal, a fall, or other traumatic [illegible]

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[illegible]

Poisoning—Description.—This condition is not common [illegible] poisonous plants or [illegible] in access to such substances as arsenic, or paint. Symptom: sudden disorder without visible cause.

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Afterbirth—Description.—May follow abortion or [illegible] occur as a result of weakness due to improper [illegible] and care. Characterized by a foul-smelling discharge with fragments of membranes protruding from the vulva. Unless relief is given, fever, loss of appetite, suppression of the milk flow, and rapid emaciation may follow. [illegible]

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SHEEP AND GOATS

Transmissible Diseases Most Frequently Observed

Anthrax.—(See .1111.)

Caseous Lymphadenitis—*Description.*—Chronic infectious disease of the lymphatic system caused by a germ. Disease seldom noticed except through a post-mortem examination. It has no noticeable effect upon sheep marketed before they are 2 years old. In older animals the glands in front of the shoulder and in the flank may become enlarged to the size of an egg. Animals show emaciation, but fatal cases are rare.

Control.—No remedy is effective. Meat of animals that does not show extensive lesions or emaciation is fit for food. Affected parts should be destroyed.

Hemorrhagic Septicemia.—(See 2114.)

Snuffles (Nasal Catarrh)—*Description.*—Exposure to unfavorable weather conditions, such as cold, rain, or snow, especially after shearing, predisposes to its development. Nasal discharge, which at first is watery and later becomes thick, stringy, and yellowish. By drying it may plug the nostrils.

Control.—Prevent by providing shelter during bad weather. Cleanse nostrils with a disinfecting solution and provide nutritious feed. As a tonic, give in the feed a tablespoonful of a mixture of equal parts of powdered carbonate of iron and powdered gentian.

Transmissible Diseases Less Frequently Observed

Blackleg.—(See .2112.) Less observed in sheep than in cattle.

Foot-and-Mouth Disease.—(See .2121.)

Infectious Abortion.—(See .2115.)

Lip and Leg Ulceration (Necrobacillosis)—*Description.*—Characterized by the formation of ulcers on any part of the exterior of the body, but usually on the lips, nose, chin, cheeks, gums, hard palate, legs, and feet, and on the sheaths of bucks and wethers. The tail stumps of docked lambs, slit ears, shear cuts, and the vulvæ, udders, and teats of ewes may also be the seat of ulcers. All ages are susceptible. The affected parts during the acute stages of the disease show inflammation, swelling, ulceration, gangrene, and sloughing. A typical offensive odor is given off by the affected parts. Heavy losses occur.

Control.—Avoid contaminated premises, and treat injuries that offer entrance to the causative germs. Isolate the affected sheep and disinfect the premises. Apply three or four times weekly a 3 per cent solution of one of the coal-tar or cresol dips, or better, a dressing containing 5 parts of one of these dips, 10 parts of sublimed sulphur, and 100 parts of mutton tallow, vaseline, or lard. Where scabs or abscesses have formed, remove or drain and apply treatment.

Lump Jaw (Actinomycosis).—(See .2123.)

Rabies.—(See .1127.)

White Scours of Lambs (Infectious Diarrhea)—*Description.*—Symptoms appear within one to three days after birth. The lamb stops suckling, is depressed, and lies down much of the time. The feces may be yellowish or grayish white and may be tinged with blood. They are fetid and fluid. Death occurs in one to several days. White scours is distinguished from simple diarrhea by its tendency to affect a large number of lambs in the flock at the same time.

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Control.—Isolate the infected lambs, and give 2 teaspoonfuls of castor oil and an internal antiseptic, such as salicylic acid in doses of one-third teaspoonful daily for several days. Anti-white-scours serum may be injected shortly after birth as a preventive. Place ewes, before lambing, in clean, disinfected quarters.

Nontransmissible Diseases

Garget—*Description.*—Inflammation of the udder due to bruises from the head of the lamb, lying in damp quarters, or heavy feeding of concentrates. Dark-red or purple discoloration of udder, refusal to let lamb nurse, loss of appetite, if neglected gangrene, and sloughing of parts.

Control.—Dissolve 3 ounces of Epsom salts in warm water and give to animal. Milk out contents of udder frequently. Bathe with hot water several times daily. Rub udder with a mixture of 2 tablespoonfuls of turpentine in 1 pound of vaseline.

Gas Gangrene (Malignant Edema)—*Description.*—Acute febrile disease with a high death rate that affects all animals. It is caused by a specific organism that usually gains entrance to the body through an open wound. Observed in sheep following castration, docking, and shearing. Characterized by the rapid development of gaseous swellings around the wound which spread to involve greater areas and show a tendency to decompose.

Control.—Medicinal treatment is useless in well-developed cases. Prevent by exercising sanitary precautions in operations, and by placing docked and castrated animals on clean ground for a time after the operations.

Goiter (Big Neck, Woolless Lambs)—*Description.*—Believed to be due to insufficiency of iodine in the feed and water. Occurs most frequently in sections where the soil is deficient in this mineral. Characterized by swelling of the thyroid gland of the neck. Often lambs from infected flocks are born woolless and with enlarged necks.

Control.—Supply of the needed iodine is the basis of prevention and treatment. May be given in the drinking water in the form of potassium iodide. One-half ounce of the compound mixed with one-half ounce of milk sugar, and dissolved in water is the daily dose for 100 ewes.

Milk Fever.—(See .223.)

Pleurisy, Pneumonia.—(See .126 and .127.)

Tetanus (Lockjaw).—(See also .128.) Often noticed in lambs following docking and castrating.

Parasites and Parasitic Diseases

Grub in the Head—*Description.*—Infestation of the nostrils and sinuses by the grubs of the fly, *Oestrus ovis.* The adult fly, which resembles an overgrown house fly in appearance, is active during the summer and deposits the grubs on the edge of the sheep's nostrils. The grubs migrate up the nostrils. Early symptoms are nasal discharge, which interferes with breathing, and sneezing.

Control.—Treatment is not very satisfactory, but prevention is simple and usually effective. Application of such substances as pine tar, fish oil, or whale oil to the noses of the sheep will prevent the flies from depositing their larvæ. May be applied by hand, or the result may be obtained automatically by making a salt lick of a log or plank, in which 2-inch auger holes are bored with salt placed in the holes and the tar or other mixture smeared about the openings so that the sheep will get it on their nostrils, as they lick the salt.

Liver Fluke (Liver Rot)—*Description.*—Infests sheep, especially in low-lying, wet pastures. In the United

States it is most prevalent in the States along the Gulf and Pacific coasts. Characteristic symptoms may be visible in early stages. Later on animals become anæmic and emaciated. Surest method of diagnosis is by postmortem examination. Flukes appear as dark, leaflike objects, one-half inch or more in length, and are found in the ducts of the liver.

Control.—Avoid use of infected pastures, and treat affected animals with male fern, preferably under the direction of a veterinarian.

Lungworm.—(See .233.)

Maggots (Fly Blow)—*Description.*—Result from the common blowfly laying its eggs in wounds, such as those of castration, docking, shearing, other injuries, and where the wool has become soiled by the feces. Animal shows uneasiness and attempts to bite or rub infested parts.

Control.—Prevent by disinfecting all wounds and applying pine tar to keep flies away. Keep the hindquarters clipped of all "taggy" wool. Spraying the breech with a 0.7 per cent solution of arsenic is preventive. Apply chloroform or turpentine to infected wounds to remove or kill the maggots, and coat with pine tar.

Scabies (Sheep Scab)—*Description.*—One of the oldest known, most contagious, and most injurious diseases affecting sheep. Caused by a mite, which irritates the skin, causing red spots from which serum oozes. These rapidly increase in size. Crusts and scabs form, and wool falls out in patches. Death comes to most of the affected animals, if treatment is neglected.

Control.—Report outbreaks to livestock sanitary officials. Quarantine the infested flocks. As disease is highly contagious, careful handling of flock is necessary. Lime-sulphur and other approved dips are the only satisfactory methods of treatment. Avoid old bed grounds and other places where infection may be present.

Screw Worm—*Description.*—Insect gains its name from the habit of the larvæ or maggots of penetrating practically sound tissue. Blowflies infest wounds and soiled wool on sheep. They breed in decayed animal matter, especially in carcasses of large animals.

Control.—Complete destruction of carcasses by burning is the approved method. This lessens danger of the spread of such diseases as anthrax and blackleg from animal to animal in pastures and prevents all breeding of flies on carcasses. If burning can not be carried out properly, bury carcasses, covering them with quicklime and at least 2 feet of soil. In treating stock watch for first signs of infestation, use benzol (100 per cent) or chloroform to kill maggots, and follow with commercial pine-tar oil to repel flies.

Stomach Worm—*Description.*—Worms are from one-half to 1¼ inches in length, about as thick as a pin, and are very common throughout the United States, especially in the South and Middle West. Eggs are swallowed with the feed and develop in the fourth stomach. Effects of infestation usually appear gradually with a dullness and general unthriftiness. Diarrhea may be present. Later the mucous membranes become pale, watery swellings appear under the jaw, and death may follow, especially in the case of lambs.

Control.—Routine medicinal treatment appears to be the most satisfactory method of control, although the avoidance of infected pastures by rotation grazing, the use of forage crops and areas previously pastured by horses or hogs, and early lambing so as to market the lambs before the summer, help to prevent the disease. In the systematic treatment of flocks, the best practice is to administer the treatment at least once a month, or

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better still every three weeks from spring to fall in the North and throughout the year in the South. The 1 per cent solution of the clear blue crystals of copper sulphate, given in doses of 3 ounces for grown sheep and about half as much for lambs, has given good results. Prepare solution by dissolving one-fourth pound of the copper sulphate in a pint of boiling water and then adding cold water to make 3 gallons. Use enamel-ware receptacles. In dosing, use a long-necked bottle, a dose syringe, or a rubber tube with a funnel at one end and a piece of metal tube at the other. It is important that the solution be prepared acurately and given in proper doses. Hold the sheep in a standing position while dosing it, and use care to prevent strangling or waste. The addition of 1 per cent of snuff or powdered tobacco to the above solution and allowing it to steep over night apparently gives somewhat more effective results.

Another treatment is a solution of nicotine sulphate, made from a commercial preparation containing 40 per cent of nicotine sulphate. Can be prepared for use in three strengths by addition of 1, 2, or 3 teaspoonfuls of the commercial solution to a quart of water, the dose being 4 ounces to an adult sheep and 2 ounces to a lamb. The weak solution is recommended for weak animals, the strong for the strong ones, and the medium for animals in moderate condition.

Ticks.—(See 8.25.)

Bladder Worm—*Description.*—Worm looks like a sac full of clear fluid, with a white object, which is the head and neck, projecting into it from one end. Light infestations seem to do very little damage. Not often observed as an economic problem.

Control.—No treatment for infestation with the bladder worm in sheep.

Hookworm—*Description.*—Common parasite of sheep in the Southern States and has been observed in other sections. Symptoms are similar to those of stomach-worm disease.

Control.—Pasture rotation and proper disposal of manure are important. The copper-sulphate and tobacco solution used for stomach worms is recommended.

Lice—*Description.*—There are three types, the biting louse, rather common; the sucking louse, fairly common in the Southwest; and the foot louse.

Control.—Biting louse may be killed by a single application of sodium fluoride dusted in the wool. Control the other forms by dipping the flock twice, with an interval of 14 to 16 days between, in a standard coal-tar creosote or nicotine dip and removing to clean premises.

Nodular Worm—*Description.*—Lives in the intestinal tract and adjacent organs. Originally observed only in Southern and Eastern States, but now found farther west. Symptoms are similar to those shown by other parasites of digestive tracts. Positive diagnosis only possible by post-mortem examination.

Control.—No satisfactory treatment; however, the copper-sulphate and tobacco solution used for stomach worms aids in control. Pasture rotation and avoidance of infected areas are helpful in prevention. Keep lambs on safe areas.

Tapeworm—*Description.*—Many varieties infest the intestines and liver of sheep, but the exact mode of infection is not known. Symptoms are paleness of skin and mucous membranes, diarrhea, the passing of worm segments in the feces, rapid loss of weight, but with good appetite.

Control.—Various drugs, such as kamala, male fern, and areca nut are used to eliminate the parasites. The copper sulphate and tobacco solution for stomach worms will also remove tapeworms. Since dogs are an interme-

diate host of some tapeworms occurring in the muscles and other tissues of sheep, they should be kept from eating raw meat and slaughterhouse refuse, and if infested, should be treated for the removal of the parasite.

Other Abnormal Conditions

Bloat.—(See .241.)

Difficult parturition (Dystocia)—*Description.*—Seen most frequently in ewes when they lamb for the first time. Parts of each of twin lambs entering the pelvic cavity at the same time are often responsible. When the head or legs are not presented in a normal manner or when the fetus is malformed dystocia is evident.

Control.—Confine the ewe, and lubricate the genital passage of the animal and the operator's hands with linseed oil. Push back the fetus in the uterus and rotate into position for normal presentation. Pass a cord over the feet, either fore or hind, according to the position of the fetus, and apply moderate traction as an aid to the efforts of the ewe. Disinfect hands and instruments. This condition should be handled by some one thoroughly acquainted with the anatomy of the genital organs.

Foot Rot—*Description.*—Noncontagious disease of the feet, usually observed in sheep that are pastured on wet or swampy lands. Animal shows lameness, and pus may be discharged from the cleft of the foot. Not often observed in simple form, most cases being of infectious nature.

Control.—Remove flock to clean, dry ground and treat lesions with disinfecting solution, such as coal-tar dip.

Gravel (Urinary Calculi)—*Description.*—Deposit of lime salts in bladder or urethra. Rams and wethers only are affected. Caused by extensive feeding on turnips, sugar beets, mangels, or feeds rich in lime salts. Animal lies down a great deal or lags when driven. A peculiar jerking movement is seen when animal is standing, and constant straining as if to urinate, but only small quantities of urine are voided.

Control.—Clip the wool from around the end of the prepuce. Flush latter with olive oil. Feed sparingly of above feeds. If the obstruction is far back the chances of recovery are slight unless an operation is performed.

Rickets (Leg Weakness)—*Description.*—Disease of lambs in which the bones are soft and flexible from the lack of proper mineral content. Symptoms most apparent in the long bones of the legs. Nodular enlargements may be observed on the ends or sides of the bones, which are soft and porous. They are bent or bowed outward, inward, or backward. Spine may also be curved. Stiffness or lameness are present. Animal does not like to move about, lies down a good deal, or crawls about on knees when eating. Second set of teeth slow in coming. Licking or nibbling of walls is observed, also a desire for filth and foul matter.

Control.—Give plenty of room and exercise, and nutritious feed grown on good soil, such as green feed, timothy hay, clover, alfalfa, pea hay, oats, linseed cake, or other feeds rich in lime and phosphates. Give chalk (calcium carbonate) to ewes with suckling lambs, or to lambs, in doses of one-half to 2 teaspoonfuls daily or sodium phosphate alternated with chalk. Cod-liver oil promotes the lime and phosphates in bones. Give one-third teaspoonful doses daily.

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Other Abnormal

Bloat.—(See 241.)

Difficult parturition (Dystocia)—*Description.*—Seen most in ewes [illegible] lamb, [illegible] first [illegible] of each of twin lambs [illegible] the same time are [illegible] responsible. [illegible] are not presented in a normal manner [illegible] fetus so malformed [illegible]

Control.—Confine the ewe [illegible] of the animal and [illegible] operator's hands with [illegible] push back the fetus in the uterus and [illegible] into position for normal expulsion. Pass a cord over the feet, either fore or hind, according to the [illegible] of the fetus, and apply moderate traction [illegible]

acquainted with the anatomy of the animal

Foot Rot.—[illegible]

or swampy lands. Animal shows lameness [illegible] discharge from the cleft of the foot [illegible] severe or simple form [illegible] infectious nature

Control.—Remove flock to clean, dry ground and treat lesions with disinfectant solution such as [illegible]

Gravel; Urinary Calculi.—*Description.*—Deposit of lime in bladder or urethra. [illegible] affected. Caused by extensive feeding on turnips, sugar beets, mangels, or feeds rich in lime salts. Animal lies [illegible] a great deal or [illegible] [illegible] movement is seen when animal is standing; constant straining as if to urinate [illegible] urine are voided.

Control.—[illegible] the wool [illegible] around [illegible] above feeds. If the obstruction is far [illegible] of recovery are slight unless an operation is [illegible]

Rickets (Leg Weakness)—*Description.*—[illegible] the bones are soft [illegible] the long bones of the legs. Nodular [illegible] observed on the ends [illegible] are bent or bowed outward, inward, or backward. Spine may also be curved. Stiffness or lameness [illegible] Animal does not like to move about; lies [illegible] of teeth slow [illegible] of want is observed, also a [illegible]

Control.—Give plenty of room and exercise and [illegible] hay, clover, alfalfa, pea hay, oats, [illegible] feeds rich in lime and phosphorus. Give [illegible] to ewes with suckling lambs, or to lambs [illegible] doses of one-half [illegible] consecutive days [illegible] alternated with chalk [illegible] lime and phosphorus in bones. Give one-third [illegible] doses daily

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HOGS

Transmissible Diseases Most Frequently Observed

Flu (Swine Influenza)—*Description.*—Widespread disease of hogs, especially where they are raised in large numbers. Herd disease characterized by the sudden prostration of a large portion of the herd, complete loss of appetite, spasmodic breathing, violent coughing when urged to move, reddened, swollen, and weeping eyes, nasal discharge often mixed with blood, and occasionally vomiting of stringy mucous matter tinged with bile. Temperature usually runs high. Course of disease is usually about one week.

Control.—Treatment is almost entirely hygienic. Place the hogs in warm, clean, well-bedded quarters with plenty of fresh air and drinking water. Give little feed or none at all for the first 24 hours.

Hemorrhagic Septicemia (Swine Plague).—(See also .2114.) *Description.*—Essentially a type of swine pneumonia and not a herd disease. Caused by a specific organism, which is apparently harmless until the vitality is lowered through diseases, such as hog cholera.

Control.—If associated with hog cholera, disease should be treated. If it appears in uncomplicated form, follow suggestions under "flu." Bacterins and serums are also being used in the treatment of this disease, but are probably worth more as preventives.

Hog Cholera—*Description.*—Most serious swine disease. Extremely contagious and characterized by complete loss of appetite, extremely high temperature, constipation usually followed by diarrhea, chills, depressions, burrowing in litter, ears and tail drooping, and often coughing. Red blotches appear on the skin of the belly, inner side of the legs, and on the ears. In advanced stages there is staggering gait and gummy discharge from the eyes, often gluing them shut. Death usually occurs in a few days, and sometimes sooner.

Control.—No known cure for hog visibly sick with this disease. Protection lies in prevention through the use of immunizing serum. While this disease is suspected or is present in the community, steps should be taken to have the herd inoculated by a competent operator. Many producers keep their entire herds immune by vaccinating each new crop of pigs. Sanitary precautions are absolutely necessary when this disease is present. After an outbreak, disinfect premises thoroughly, and burn or bury carcasses of dead animals.

Necrobacillosis (Necrotic Enteritis)—*Description.*—Caused by a filth-borne germ, such as the necrosus bacillus, which gains entrance to wounds, abrasions, or other weakened tissues, and causes a characteristic sloughing. Most commonly observed in growing pigs as an affection of the face and snout, shown by an enlargement and sloughing of the parts, or of the intestinal tract as a sloughing inflammation.

Control.—Prevention is all important and consists in providing sanitary surroundings for hog-raising operations and proper feeding. Affected animals should be removed to clean quarters, preferably pasture, and given nutritious feed and pure water. One ounce of pulverized copper sulphate added to each 25 gallons of drink-

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ing water may be effective in alleviating intestinal symptoms. External lesions should be thoroughly cleansed, after which a mixture of 15 parts of glycerin and 1 part of carbolic acid, or 50 per cent solution of iodine may be applied.

Tuberculosis—*Description.*—Widespread disease among hogs, but on account of the early age at which most hogs are slaughtered, it is often not detected during life. Usually contracted from the milk of tuberculous cows, by hogs following tuberculous cattle in the feed lot, or from poultry.

Control.—Feed hogs with only Pasteurized dairy by-products or those from tuberculin-tested herds. Maintain tuberculosis-free herds of cattle and flocks of poultry. Tuberculin test is being used successfully to detect the presence of tuberculosis in hogs.

Transmissible Diseases Less Frequently Observed

Anthrax.—(See .1111.) *Description.*—Hogs are less susceptible to anthrax than cattle and sheep, though in a few cases they have been known to contract the disease.

Control.—Burn or bury carcasses. Disinfect quarters. Outbreaks should be reported promptly to the proper State authorities and their advice followed in the suppression of the malady.

Erysipelas—*Description.*—Specific germ infection of the skin. Characterized by the formation of well-defined, slightly elevated, diamond-shaped areas, of dark-red color. In extreme cases it extends over a considerable portion of the body surface and may be associated with more or less sloughing.

Control.—Sanitation of the hog lot, proper methods of feeding and management, medicated concrete hog wallows, and dipping of the animals in a standard disinfecting bath are advised.

Foot-and-Mouth Disease.—(See .2121.)

Infectious Abortion—*Description.*—This disease when affecting hogs may cause considerable loss from the failure of sows to farrow pigs that live. Probably becoming more widespread and is rather common in the larger hog-breeding areas of the Corn Belt. Characterized by the expulsion of immature pigs and may affect practically all sows in the herd during one gestation period.

Control.—Medicinal treatment is without value. Rigid quarantine and sanitary measures in combination with proper feeding and care give best results. Remove healthy sows from the aborters. Provide clean premises. Burn aborted pigs, afterbirths, and all contaminated feed and litter. Disinfect infected quarters. Do not breed aborting sows until all discharge has ceased and they have passed two or three heat periods. Consult a qualified veterinarian.

Nontransmissible Diseases

Cannibalism (Pig Eating)—*Description.*—Condition in which sows eat their newborn pigs. Causes are the lack of some needed element or elements in the ration and probably imitation when sows are run together.

Control.—Prevention by providing proper feeds, particularly those containing plenty of protein and mineral matter, is of prime importance. Avoid for breeding purposes further use of sows confirmed in the habit. A sow that shows this tendency should be fed a protein supplement, such as tankage and milk, and the pigs separated from the sow except during the nursing period.

Eczema—*Description.*—Although rare among mature hogs, it is not uncommon in pigs. Usually appears as a secondary ailment in pigs left unthrifty as the result of disease, such as chronic cholera, chronic indigestion, rheumatism, rickets, scours, and heavy infestation of lice. First appears in the form of red elevations of the skin in various parts of the body accompanied by severe itching. Small blisters appear, which are filled with a sticky fluid that later turns into pus. When blister breaks a scab forms. Skin may become thickened and cracked.

Control.—Provide sanitary quarters. The common factor responsible for practically all forms of skin diseases in hogs is the filthy condition under which they are raised and kept.

Ergotism.—(See .221.)

Garget—*Description.*—Inflamed condition of the udder caused by injuries, injudicious feeding, or cold and damp quarters. Udder is hot, swollen, painful, milk flow is suppressed, and sow refuses to nurse pigs.

Control.—Make hot applications to udder and keep it well lubricated with soothing ointments. Administer 1 or 2 tablespoonfuls of castor oil. Completely fill hollows in front of doors to prevent injury to udder on door sill.

Pleurisy, Pneumonia.—(See .126 and .127.)

Posterior Paralysis—*Description.*—Condition usually comes on gradually, unless caused by an internal injury. Often the first indication is a wabbly gait, followed by an inability to stand and the dragging of the hind quarters when animal is forced to move. May be caused by injury in handling, shipping, or breeding, or by tumors or other abnormal growths affecting the spinal cord, but probably most often a deficiency of mineral matter in the ration and lack of exercise, especially in a sow after parturition.

Control.—Provide a balanced ration, particularly one containing sufficient minerals and green stuff, and give exercise necessary to good health as a preventive measure. When the condition is present, the first step in treatment is to make the animal as comfortable as possible. Give a physic of Epsom salts or raw linseed oil, if animal is constipated, and feed a light diet, such as bran mash, milk, and green alfalfa or clover. It may be advisable to wean the pigs. The administration to each affected sow of 1 tablespoonful of cod-liver oil, 15 grains of precipitated phosphate of lime, and 3 drops of fluid extract of nux vomica twice daily in the feed, has given good results.

Rheumatism—*Description.*—There are two types, affecting either the muscles or the joints, but neither is of frequent occurrence. Cause may be the absorption of toxic material, exposure in damp and drafty quarters, or being shipped. Painful and difficult locomotion are symptoms.

Control.—Treatment is largely preventive and consists of hygienic measures. Drugs are of little or no benefit.

Rickets—*Description.*—Disease or condition impairing or interfering with the development of the bony structures in young animals. Has its origin in a diet deficient in bone-forming salts. Legs begin to bow, back drops, gait is spraddling, and hard swellings occur on the head and joints. Affected animals are stunted and pot-bellied.

Control.—Feed more milk, oil meal, tankage, clover, or alfalfa crops, and less corn. Keep wood ashes or charcoal available. Give 2 to 10 grains of precipitated calcium phosphate to each pig in milk or feed and expose pigs to sunlight.

Tetanus.—(See .326.)

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Parasites and Parasitic Diseases

Kidney Worm—*Description.*—One and one-half to two inches in length, striped in color. Usually found in the fat surrounding the kidneys. Form pus pockets in the tissues and when these are cut open one, two, or more worms are found. Sometimes found in the kidneys and liver.

Control.—Same as for round worms.

Lice—*Description.*—Observed wherever hogs are raised and occasion considerable harm from loss of blood and irritation to the skin. Parasite completes its life cycle on the hog and ordinarily infests no other animals. Lives only a few days when separated from its host.

Control.—Keep premises, such as small inclosures, in clean and sanitary condition, spraying occasionally with a standard coal-tar disinfectant. Medicated wallow or dipping vat will help to keep lice down. Rubbing posts saturated with crude oil are also beneficial.

Lungworm—*Description.*—Reddish, threadlike worm one-half to 1 inch long, which is a parasite of the lungs. Usually pigs only are infested. Animal shows unthriftiness, coughs violently, and has nasal discharge—symptoms similar to those of pneumonia, which often develops.

Control.—No satisfactory treatment. Keep young pigs away from older pigs, and on clean ground.

Mange (Scabies)—*Description.*—Skin affection caused by two different varieties of mites that burrow into the skin, or enter the hair follicles and cause an irritation, which if not arrested may lead to considerable loss.

Control.—Systematic and through use of disinfectants in keeping quarters clean is always advisable. Treatment consists in the application of a reliable disinfectant at regular intervals to all animals of an infested herd. May be used by hand applications, by spraying, by patented oilers, by rubbing posts, by medicated wallows, and by dipping. Dipping is the best method and should be used if practicable. The following remedies have proved effective: Crude petroleum, cottonseed oil, and kerosene, equal parts; kerosene and lard, mixed in proportions of one-half pint of kerosene to 1 pound of lard; lime-sulphur; coal tar; and arsenical dips.

Roundworm—*Description.*—Very common, large, pinkish or yellowish worm that infests the intestinal tract of swine and causes heavy losses, especially among young pigs. Symptoms are general unthriftiness, stunted growth, thumps, and often pneumonia. Infestation takes place through the eggs, which are passed out with the feces and are swallowed with feed and water.

Control.—The following system of sanitation based on the life cycle of the parasite has been found effective in reducing to a minimum or avoiding losses from this worm:

(1) Use farrowing pens of sanitary construction. Before farrowing time thoroughly clean the pens of all trash and manure, and scrub the walls and floor with a stiff brush, plenty of hot water, soap, and lye.

(2) Before placing the sows in the farrowing pens thoroughly clean their bodies with soap and water, paying particular attention to the udders and under parts of the body.

(3) Within 10 days after farrowing remove the sows and pigs by hauling them onto a field that previously has been sown to a forage crop and not since occupied by hogs. Provide individual houses that have been cleaned as before recommended, access to pure water, and supplemental feeds. Allow no other hogs on such pastures. Keep the pigs under these conditions until they are 4 months old, removing the sow at weaning time.

In fall farrowing the sows may be allowed to farrow in the individual houses located in such a pasture as described above. Hog lots should be plowed up occasionally and sown to crops. Abolish the filthy hog wallow and other insanitary quarters.

Other Abnormal Conditions

Abscesses—*Description.*—Local infection or "boil." May be caused by confining hogs to filthy quarters. Germ gains entrance through hair follicle, and abscess usually forms in region of the belly.

Control.—Make incision with a sharp knife and let drain. Use disinfectant wash.

Choke (Obstruction of Gullet)—*Description.*—Caused by hog attempting to swallow a piece of potato, apple, turnip, or other hard feed before it is sufficiently chewed. Hog suddenly stops eating, stands with outstretched head and neck, nose held close to the ground, mouth open, and saliva flowing freely. Animal gasps and makes effort to vomit.

Control.—More difficult to treat than in other animals. Dangerous to drench a hog. Material may be reached with the fingers or with large forceps or pincers. May be necessary to give dose of linseed oil. Condition is usually serious enough to require trained service.

Fracture—*Description.*—Complete or partial breaking of a bone or bones.

Control.—If animal is exceptionally valuable it may be advisable to attempt to treat the case. In other cases immediate slaughter is advised.

Hairlessness of Pigs—*Description.*—Condition in which pigs are born with little or no hair is usually associated with goiter in sows and seems to be due to lack of iodine in the ration.

Control.—Condition may be avoided by the feeding of 2 grains of potassium or sodium iodide daily to the pregnant sow during the gestation period. May be dissolved in water and given with the slop and other feed.

Heat Stroke (Overheating)—*Description.*—Hogs are very susceptible to overheating, show signs suddenly, will apparently gasp for breath, grow restless for a few minutes, wabble in their walk, and finally fall over on their sides, going into convulsions. Prompt attention is necessary if they are to be saved.

Control.—Provide plenty of shade both in the hog lot and in the pasture, as well as a concrete wallowing tank. When animal shows signs of heat prostration pour cold water on the head, but not over the entire body. Keep this up until animal shows signs of reviving. Aromatic spirits of ammonia in teaspoonful doses for 100-pound hogs as a stimulant is beneficial.

Hernia (Scrotal Rupture)—*Description.*—Caused by an enlarged inguinal ring, permitting parts of the intestines to enter the scrotum. In the usual case, the harm comes from the restriction to the passage of the intestinal contents on through the bowel, resulting in inflammation and usually death.

Control.—Castration of the animal by the so-called covered operation is advised in all cases of scrotal hernia.

Poisoning—*Description.*—Common occurrence in hogs from the ingestion of spoiled feed, excessive quantities of cottonseed meal, poisonous plants, lye, cockleburs, too much salt, or ordinary disinfectants. Symptoms vary

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with the causative agent and in some cases may resemble cholera, but the absence of fever will differentiate.

Control.—Keep poisonous substances from being eaten by hogs. Medicinal treatment is usually of little value, but emetics in early stages followed by purgatives may help.

Thumps (Spasms of Diaphragm)—*Description.*—Same as hiccoughs in the human being, due to an overstimulation of the pneumogastric nerve, which in turn causes a spasmodic jerking of the diaphragm. May be caused by lack of exercise and improper feeding. May occur as a symptom of digestive diseases, such as inflammation of stomach, intestines, or heavy infestations of worms. Often is associated with cholera and swine plague. Worm embryos migrating through the lungs may also cause thumping, especially in young pigs.

Control.—Prevention by proper feeding, protection against worms, and general hygienic measures is to be sought. Recovery is usually rapid if the cause is promptly removed.

POULTRY

Transmissible Diseases Most Frequently Observed

Chicken Pox (Diphtheria)—*Description.*—Serious infectious disease, most commonly observed in chickens, but other birds are susceptible. Characterized by the eruption of pox nodules on the head and by the presence in the mouth, throat, and eyes, of tough, cheesy patches which are firmly attached to the underlying tissues.

Control.—Treatment of severe outbreaks requires much time and patience, and as a rule does not pay. Often better to kill the infected birds, bury or burn the carcasses, and thoroughly disinfect the premises. Add one-third teaspoonful of permanganate of potash to each gallon of drinking water. A vaccine has been used for the prevention of the disease, but the results are variable.

Fowl Cholera—*Description.*—Highly infectious and rapidly fatal disease. Birds of any age are susceptible. Spreads rapidly through the flock. First symptom is a yellowish coloration of droppings, followed by diarrhea. Birds become droopy, feverish, sleepy, and sit with head drawn down to the body or turned backward and resting on the feathers about the wing. Appetite diminishes, and thirst increases. In very acute cases no symptoms are seen, for the birds are found dead under the roosts or fall over while feeding. Can be positively distinguished from other diseases by laboratory test.

Control.—Treatment of affected birds is futile. Kill and burn or bury the carcasses. Remove the healthy birds to new quarters. Clean and disinfect quarters with carbolic acid in 5 per cent solution or other standard disinfectant. Make drinking water antiseptic by adding one-third teaspoonful of permanganate of potash to each gallon.

Roup (Contagious Catarrh)—*Description.*—Contagious; affects the eyes, nose, and throat. First signs are watery eyes, swollen eyelids, loss of appetite, and thin watery discharge from nostrils, which becomes thick and interferes with breathing. Frequently develops from a hard cold, but more often brought into the flock by other birds. Discharge from nostrils and mouth carries the germs.

Control.—Remove the sick birds from the flock and place in warm, dry quarters with plenty of fresh air but no drafts. Cleanse eyes with warm salt water. Wash eyes with a solution containing 2 heaping teaspoonfuls of boric acid or a small half teaspoonful of permanganate of potash dissolved in water, 1 pint. Next grease the head with camphorated oil or carbolated vaseline. In severe cases kill the birds at once, as seldom, if ever, can they be fully and permanently cured.

White Diarrhea of Chicks—*Description.*—Commonly used term which covers the various diseases of chicks from time of hatching until they are 1 month old. There are four important infectious diseases which induce whitish diarrhea, namely, Salmonella pullora infection, coccidiosis, brooder pneumonia, and cholera. Chicks huddle together, appear listless, stupid, sleepy; plumage loses its luster; wings droop; and diarrhea soon appears. When infection is present the losses vary from 50 to 80 per cent of chicks hatched.

Control.—Medicinal treatment is futile, except in the coccidial form, as it has very little effect. Give chicks sour milk or buttermilk to drink. Add one-third teaspoonful of crude catechu to a gallon of drinking water. Avoid by preventing the causes.

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Transmissible Diseases Less Frequently Observed

Aspergillosis—*Description.*—Fungous disease of the lungs and air sacs. May affect any of the domestic birds. Often causes heavy losses in baby chicks and is then known as brooder pneumonia. Moldy feed is responsible in most cases. Always fatal; young birds live only a few days. Bird shows difficulty in breathing, fever, diarrhea, great depression, finally death by suffocation.

Control.—Use clean, bright straw or chaff for scratching purposes. Keep house and yards clean, and avoid moldy and unsound feed. Remove sick birds from the flock. Burn or bury the carcasses. Disinfect premises.

Blackhead—*Description.*—Disease of the intestines. Affects the turkey the most, but may also attack chickens. The cause is a parasitic microorganism which leaves the body of infected birds with the excrement and enters other birds with the feed and drink. Symptoms are diminished appetite, diarrhea, dullness, weakness, and often the peculiar discoloration of the head. Post-mortem shows enlarged liver, which is covered with degenerated, yellowish-green spots of varying size. Apparently the cæcum worm is involved in the transmission of this disease.

Control.—Medicinal treatment has not been successful. The following preventive measures may be used:

(1) Obtain eggs for hatching from birds believed to be healthy.

(2) Wipe the eggs with a cloth wet with denatured alcohol (80 to 90 per cent) before placing them for hatching.

(3) Immediately after young birds are hatched place them on clean ground not recently occupied by other fowls.

(4) Exclude all fowls, wild birds, rats, and mice from the premises occupied by the birds.

(5) Kill affected birds, burning or burying the carcasses.

(6) Use control measures for worms.

Coccidiosis—*Description.*—Disease of the intestinal tract that affects all domestic birds, being especially destructive to young chicks. The characteristic white diarrhea, frequently mixed with blood, is usually present. It runs a rapid course, and losses are heavy if vigorous treatment is not used. Disease is introduced by affected birds that are brought onto the premises or by pigeons.

Control.—Procure eggs and breeding stock from flocks known to be healthy. Exclude pigeons from poultry yards. Place one-third teaspoonful of crude catechu in each gallon of drinking water, or a like quantity of permanganate of potash. Feed sour milk or buttermilk. Keep up treatment until all signs of disease disappear. Disinfect premises with a 5 per cent compound cresol solution. Burn or bury carcasses.

European Fowl Pest—*Description.*—Disease was unknown in the United States until 1924, when outbreaks were recognized in several of the Eastern States, especially in the vicinity of marketing centers. Affects chickens, turkeys, and geese, and possibly other domestic fowls. Disease is characterized by its extremely infectious nature, rapidly progressive course, and high mortality. Often no symptoms are noticed until the bird is found dead. Others sicken rapidly, showing loss of appetite, irregular walk, extreme droopiness, swelling and darkening of the comb and wattles, and a sticky exude that glues the eyes together and clogs the nasal passages. Death usually ensues in two to five days.

Control.—No medicinal remedy. Take preventive measures to limit the spread of the disease. Kill sick fowls and burn or bury the carcasses. Remove healthy birds to new quarters. Watch for signs of the disease. Disinfect houses and yards with a strong disinfectant. Report cases to livestock sanitary officials.

Favus (White Comb)—*Description.*—Contagious disease that begins with the formation of grayish-white spots on the comb, ear lobes, and wattles. Most frequently seen among chickens and turkeys. Affected spots are later covered with dry, scaly, dirty-white crusts with an irregular surface. As the disease advances the neck and body are affected, and the feathers become brittle and break off, leaving deep depressions.

Control.—Isolate infected birds from the flock. Apply tincture of iodine or antiseptic ointment to affected parts daily. Disinfect premises, and destroy dead birds by burning.

Fowl Typhoid—*Description.*—Infectious disease of mature chickens attacking the blood and internal organs. Spreads through a flock in a manner similar to cholera but is not so destructive as acute cholera. Symptoms of fever and general weakness are present but are not characteristic. Post-mortem shows pale and enlarged liver and spleen and thin blood with little tendency to clot.

Control.—Treat the same as for cholera. Use strict sanitary measures.

Tuberculosis—*Description.*—This disease is no doubt much more prevalent among poultry than is generally recognized. It is usually introduced by the purchase of new stock and gains entrance to the body with feed and water contaminated with the droppings that carry the infection. Symptoms are usually not observed until the disease reaches an advanced stage and then show as a gradual losing of weight, possibly enlargement of joints, with lameness, dullness, and diarrhea. On post-mortem grayish-white or yellowish tumors are observed in the internal organs, especially the liver, spleen, and intestines. When cut these tumors present a solid, grayish, glistening interior, which in later stages may be cheesy and crumbly.

Control.—No medicinal treatment is effective. Birds showing symptoms should be destroyed and carcasses burned. Those in good flesh may be used for food. Thoroughly disinfect the premises, and keep free from fowls for at least a year. In restocking make sure that foundation stock is healthy. When the breeding value of the flock is great or for other reasons it is not desirable to dispose of the entire flock, the disease may be controlled by disposal of all birds at the end of the second laying period and of younger ones when symptoms are shown. Unless known to be free from this disease, poultry should not be allowed to run with the hogs, as the infection may be transmissible to them.

Vent Gleet—*Description.*—Infectious venereal disease of fowls which is spread by the male in copulation. Characterized by inflammation and ulceration of the cloaca and vent, and foul-smelling droppings.

Control.—Little success from treatment. Killing the affected birds is advised. Confine roosters while the disease is present in the flock.

Nontransmissible Diseases

Gout—*Description.*—Increased quantity of uric acid in the blood from prolonged feeding on substances rich in albumen, especially if associated with lack of exercise,

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causes gout. Joints of feet become swollen and painful. Later the lesions form into nodular, tumorlike growths. Frequently the swellings burst, discharging a yellowish, turbid material containing urates. Bird avoids walking, remains in sitting position, and becomes emaciated.

Control.—Artificial Carlsbad salts have proved beneficial. This is prepared by mixing together sodium sulphate, 22 grams; potassium sulphate, 1 gram; sodium chloride, 9 grams; sodium bicarbonate, 18 grams. Six grains (or one-fifth of an ounce) of this mixture is added to 1 quart of drinking water. Tincture of colchicum in doses of 2 to 5 drops per bird may be used. Enlarged joints may be opened and contents washed out. Prevent by proper diet.

Limberneck—*Description.*—Symptom of several diseases, but most commonly of poisoning from the ingestion of spoiled feed, putrid meat, or maggots. Characterized by a paralysis of the muscles of the neck, which makes it impossible for the bird to raise its head.

Control.—Prevent birds from eating material containing the causative agents. Treat by giving one-half teaspoonful of Epsom salts or 3 teaspoonfuls of castor oil for a grown bird. Unless condition is treated early there is little hope of recovery.

Simple Catarrh (Colds)—*Description.*—Mild inflammation of nasal passages. Bird is dull in appearance, appetite diminished, breathing difficult, watery discharge from nostrils.

Control.—Wash out nostrils twice daily with boric acid in 3 per cent solution or permanganate of potash, 1 dram (about a teaspoonful) to a pint of water.

Parasites and Parasitic Diseases

Gapes—*Description.*—Disease of chickens which develops during the first few weeks of their lives and is made evident by frequent gaping. Caused by a parasitic worm which attaches itself to the internal surface of the windpipe, sucks blood from the mucous membrane, and makes breathing difficult. Observed in chicks from 10 days to 4 weeks old. Bird coughs or sneezes with an abrupt whistling sound and a more or less labored effect. Extends neck, opens the beak, and has ravenous appetite, but in spite of quantity of food eaten becomes weak, anæmic, and emaciated. As disease advances the wings droop, and bird stands with closed eyes and neck drawn back into the body.

Control.—Use an extractor. Generally a small feather is stripped of all its web, except a small tuft at the end, and is used either dry or moistened with kerosene or oil of turpentine. A fairly good extractor may be made by taking a hair from a horse's tail, bending it in the middle, and twisting the two ends together so as to form a loop, or a similar loop may be made by cutting the hair, laying the two pieces side by side, tying them into a knot near the ends, trimming the short ends close to the knot, and twisting the long ends together. Force the chick's beak open with the thumb and fingers of the left hand, while the extractor is held in the right hand. Insert extractor carefully in the small aperture at the root of the tongue, give two or three turns, withdraw, and drop worms into a basin of hot water or burn them.

Best method of prevention is to put chicks when hatched on fresh ground, to treat as they show symptoms, to plow and seed down the old infected runs, and not to

permit chickens to use them again for two or three years. Avoid running young chickens and turkeys together.

Lice.—(See 8.27.)

Mites.—(See 8.27.)

Roundworm—*Description.*—Particularly injurious internal parasite of poultry, especially if infestation is heavy. The large worms are from 1 to 2 inches long and occur in the small intestine, and the small worms, up to one-half inch in length, in the blind gut. Infection takes place from swallowing of worm eggs, which pass out with the droppings.

Control.—Treat by adding to the mash a very fine tobacco dust containing at least 1½ per cent of nicotine in proportions of 2 parts by weight of the dust to 98 parts of mash for a period of 3 to 4 weeks. May be repeated as often as necessary, if intervals of 3 to 4 weeks are allowed between periods. Thoroughly clean houses and yards, removing several inches of surface earth, and give fowls new and enlarged range.

Scabies (Depluming Mite)—*Description.*—Fowls are sometimes infested by an itch mite which lives at the base of the feathers, causing an intense itching and producing a disease known as mange or depluming scabies. Bird pulls feathers, and stumps are surrounded by scales and crusts. Mites are introduced by affected fowls and spread rapidly. Disease usually begins in the spring, is most active in warm weather, and largely disappears in winter.

Control.—Anoint affected parts with a mixture composed of 1 part of flowers of sulphur with 4 parts of vaseline or lard, or 1 part of carbolic acid with 50 parts of vaseline. A convenient liquid preparation is made by mixing Peruvian balsam, 1 ounce, and alcohol, 3 ounces. Select one of these preparations and apply at least twice, with an interval of a week or 10 days. It has been reported that both depluming mites and lice may be eradicated with one treatment by dipping in the following solution: Sodium fluoride, three-fourths ounce; sulphur, 2 ounces; laundry soap, one-half ounce; water, 1 gallon. Keep the dip stirred so that the sulphur will be kept in suspension.

Scaly Leg (Mange of Leg)—*Description.*—Itch mite attacks legs, may also attack comb and wattles. Disease occurs in most cases as a result of association with infested birds. Spreads slowly, and many birds escape it entirely, although constantly exposed to it. Feet and legs become rough; parasite attacks the clefts between the toes and spreads upward until whole of foot and shank is affected.

Control.—Smear the roosts with wood preserver or crude oil. Isolate the infested birds, wash legs with soap and warm water, dry, and apply an ointment containing 2 per cent carbolic acid, or sulphur ointment, or the Peruvian-balsam wash repeated as often as necessary. Another good remedy is made from the mixing of oil of caraway, 1 part, with vaseline, 5 parts, or the caraway oil may be mixed with 5 parts of castor oil and rubbed gently on the skin. A large number of birds may be treated by having their legs dipped in one-half pint of kerosene and 1 pint of raw linseed oil in a quart can. Take it to the poultry house at night, dip the feet, and place the birds back on the roost. Repeat as indicated. Heavy scabs may be trimmed off.

Tapeworm—*Description.*—Several kinds of these worms infest poultry. All tapeworms have a head at the narrow end of the body, the body being flattened, elongated,

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and made up of numerous segments. When present in large numbers they are very injurious. Some worms may cause nodules where head attaches to intestinal wall.

Control.—No very satisfactory treatment, so preventive measures must be depended upon. Clean houses and yards frequently and thoroughly, turning droppings under or otherwise disposing of them, so as to render the return of infected material difficult or impossible. Yards should be spaded, plowed, or surface earth entirely removed. Change quarters occasionally, and increase size of range.

Other Abnormal Conditions

Bumblefoot—*Description.*—Term applied to a swelling of the foot, which may result from such bruises as are caused by heavy birds jumping from high perches to hard surfaces, or it may be due to cuts or punctures of the skin which become infected with germs. Inflammation and the formation of an enlargement filled with fluid or cheesy suppurative material in the ball of the foot follow.

Control.—Apply tincture of iodine to swollen area daily for several days. Lance the swelling, and wash out contents if necessary. Soak the interior of the abscess with 5 per cent carbolic acid or tincture of iodine and keep bandaged for a few days.

Crop Bound (Impacted Crop)—*Description.*—Overdistended or paralyzed condition of the crop, generally caused by overeating or by swallowing of coarse and indigestible material.

Control.—Give the affected fowl a dose of sweet oil, and carefully massage the upper part of crop and gullet, while holding the head downward in an effort to remove the contents. If effort is not successful, an incision may be made through which the material can be removed, after which the opening is sewed up.

Egg-Bound—*Description.*—Inability to pass the egg in the normal manner. Frequent occurrence in fowls, especially in pullets when they begin to lay. May be due to inflammation, stricture, or tumor formation in the posterior part of the egg passage. Affected hens become restless and make frequent visits to the nest in effort to lay.

Control.—Remove the egg in the following manner: Pass the forefinger through the vent. Take the other hand and press the abdomen, forcing the egg toward the vent and guiding it by the aid of the inserted finger. When the shell is observed through the vent, puncture with an awl or sharp instrument, break it in pieces, and withdraw eggshell and contents. Isolate the bird and inject cold water into the common passage into which the intestines and the oviduct open to reduce the inflammation. If the oviduct has been everted through the vent, clean and push the parts back and inject cold water frequently until tissues remain in place.

Leg Weakness—*Description.*—Not a specific disease, but is a symptom associated with a number of diseases, or a result of mineral and food poisons. Rickets, lack of vitamins in feed, close confinement of growing chicks, and paralysis may be other causes.

Control.—Determine the cause and treat accordingly. Feed ground oyster shells or calcium phosphate freely. Add 1 dram of copperas to each gallon of drinking water. Young chicks may need cod-liver oil, 2 or 3 drops per bird, mixed in the feed daily. Leg weakness is preventable in young chicks if access is given to direct sunlight and green vegetation.

CONTROL METHODS

General

Hygiene has to do with health preservation. Sanitation has to do with measures which destroy or make harmless the germs of disease. Pure air, clean water, wholesome feed, ample exercise, and nonexposure to actual disease are essential. The following terms are defined on account of their increased use in the discussion of livestock diseases:

Antiserum.—Commonly called serum; is the defibrinated blood, whole or clarified, of animals that have been treated with substances such as microorganisms or toxins, so as to produce in that blood properties that will protect animals against the corresponding organisms or toxins.

Bacterins.—Killed microorganisms of specific diseases in suspension in a preserving liquid.

Immunity.—Effective resistance of the cell, the organism, or the individual to pathogenic infection. May be natural or acquired.

Mallein.—Endotoxin of the killed organism of glanders (*Bacillus mallei*). Used as a diagnostic agent in detecting glanders.

Tuberculin.—Sterile liquid containing the growth products of the tubercle bacilli, the causative agent of tuberculosis. Used as a diagnostic agent.

Vaccine.—Substance containing living or attenuated bacteria, which when introduced into the body stimulate healthy tissue to produce substances destructive to the corresponding bacteria.

Virus.—Active pathogenic principle of certain diseases.

Natural

Altitude and Latitude.—Spread of disease is affected by the changes in the temperature at different altitudes and latitudes. As an illustration, the Texas fever tick is absent in the high mountain districts of infected areas.

Cycles.—Some diseases seem to make periodic appearances, not that they are entirely absent during the interim, but are of less severe type. This is probably due to the gradual lessening in the degree of immunity developed by successive generations of animals after a disease epidemic.

Immunity.—Some species of animals are naturally immune to diseases that are extremely fatal to others. For example, hog cholera affects no other species of farm animal. One attack of many diseases confers an immunity, which may protect the animal against future attacks of the same disease for varying periods, and sometimes for life.

Moisture.—In connection with heat, moisture is responsible for hastening the development of many disease germs and parasites, and thus may shorten the period during which the animals are exposed.

Oxidation.—Disease germs, like all other organic matter, are subject to the effects of the elements, which under favorable conditions render many of them harmless, through the process of oxidation.

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Sunlight.—The rays of the sun alone are a powerful disinfecting agent in disease control. Direct sunlight will kill many germs or reduce their virulence. If passed through glass, its disinfecting powers are greatly lessened.

Physical Obstacles.—The presence of mountains, rivers, oceans, or lakes often confines diseases to a restricted territory by limiting the transportation of the causative agent.

Seasons.—Parasitic diseases, particularly those caused by parasites that pass part of their life cycle elsewhere, are more prevalent during seasons that favor their propagation or development while separated from the host animal. Warm, moist surroundings favor parasites.

Soil Types.—Such diseases as rickets and goiter, which are caused by a deficiency of minerals necessary for health and normal development, occur almost entirely in regions, or on farms, where the soil is lacking in lime and iodine content. Low, damp soil, containing much humus, will retain the germs of many diseases in an infective condition much longer than loose, sandy soils. Examples of this are found in such diseases as anthrax and blackleg, where certain areas are known to have maintained infection for many years.

Artificial

Biologics.—Products of the biological laboratory help in the prevention, detection, and treatment of animal diseases like hog cholera, anthrax, blackleg, tetanus, and rabies.

Change of Quarters.—Removing animals from infected areas or quarters and the intelligent rotation of pastures based on the life cycle of certain parasites help to prevent and to control disease.

Cultivation.—Plowing of feed lots, care of pastures, and adoption of definite rotations will do much to combat the propagation of animal parasites.

Disposition of Excrement.—Manure is the principal carrier of the eggs and larvæ of internal parasites. As a rule, horse manure is most dangerous for horses, since it carries material infective for horses, but not ordinarily transmissible to cattle, sheep, and hogs. Cattle, sheep, and goat manure is dangerous for these three classes of animals since they have many parasites in common, but is much less dangerous for horses and hogs. Hog manure is dangerous for hogs and much less so for other kinds of animals. It is therefore advisable in removing manure from the barns and lots to put it on the fields occupied by animals of a kind different from those furnishing the manure. When possible manure should be plowed under promptly to destroy eggs and larvæ.

Disposition of Carcasses.—Carcasses of animals that die from infectious disease or from unknown cause are dangerous sources of future infection and should be disposed of in such a manner as to minimize this danger. The preferred methods are: (1) By complete burning or cremation, (2) by burning or burying, and (3) by tanking at rendering plant. Burning may be accomplished if carcass is placed on some iron bars over an excavation in which a slow fire is maintained until carcass is entirely cremated. The addition of kerosene to the carcass will hasten the process. A cross-shaped excavation provides better drafts than a straight ditch. In burying select a location that is protected from washing and drainage into a stream. Excavate a hole sufficiently large to accommodate the body lying on its side and deep enough

so that from 4 to 6 feet of earth will be over it when it is covered. The placing of a half barrel or more of quicklime on the carcass of a large animal after it is placed in the grave is advisable.

Disinfection.—(See 3.85.) Disease germs can be partially or wholly destroyed by the use of disinfectants or germicides. These substances are not cures for disease, but tend to prevent its spread by acting against the causative agent. Some disinfectants are rather specific in their action, in that they kill some germs and not others. The worth of a germicide depends entirely upon its power to destroy germs, which property is not indicated by the odor, color, or other physical characteristics. The physical disinfectants, such as sunlight, fresh air, heat, and cold have already been mentioned. Some of the most common and useful disinfecting agents, their methods of preparation and uses, are as follows:

(1) *Bichloride of mercury* (*corrosive sublimate*).—Dissolve in water in a strength of 1 to 1,000. Disadvantages are that it is a dangerous poison, unites with albuminous substances to form inert compounds, and corrodes metal.

(2) *Chemically pure carbolic acid* (*phenol*).—Use in 5 per cent solution in water. Very poisonous and more expensive than most disinfectants. Carbolic acid in the crude form is also sometimes used, but on account of its varying strength is not dependable.

(3) *Cresol.*—A 2 per cent solution in warm water is very effective.

(4) *Compound solution of cresol* (*liquor cresolis compostus*).—This substance mixes readily with water and in solutions of 3½ to 4 per cent is an effective disinfectant.

(5) *Formaldehyde.*—Most commonly used in the form of formalin, which is a solution of approximately 40 per cent strength. When mixed in the proportion of 6 ounces to the gallon of water it makes a very good disinfectant for hay, grain, or other feed that has become contaminated. Also used in the gaseous form as a fumigant for buildings that can be made practically air-tight. A simple method of liberating the gas is to place crystalized or powdered permanganate of potash in a wide-surfaced noncombustible container and pour the formalin on it. The proportions are 16⅔ ounces of the permanganate of potash to 20 ounces of the formalin.

(6) *Emulsified coal-tar products* (*dips*).—These are widely distributed on the market under a variety of trade names. See that they meet the approved standard, and use as indicated on the label.

(7) *Permanganate of potash.*—Perhaps most used as an addition to drinking water, especially for poultry.

(8) *Quicklime.*—A cheap and good disinfectant, commonly used in the form of "milk of lime," made by slaking the lime with 1 pint of water to each 2 pounds of quicklime, and then adding four times the volume of water. It is especially useful for scattering about yards, lots, and interiors of buildings.

(9) *Chloride of lime.*—When mixed with water in the proportion of 6 ounces to 1 gallon, it is a fairly good disinfectant and a powerful deodorant.

In the process of disinfection thoroughness is all important. The first step is to remove all dirt, manure, and other filth. Dampen all surfaces before sweeping or scraping to avoid scattering germs in the dust. Apply a disinfectant to all material removed, then thoroughly soak all exposed surfaces with a disinfecting solution and keep animals out for a period. Feed boxes may be scalded with boiling water to which a small quantity

of lye has been added. Immerse blankets in a bichloride of mercury solution or steam them and wash harness, pails, currycombs, brushes, forks, and shovels with a cresol disinfectant.

Isolation (Quarantine).—The isolation of affected and exposed animals is one of the most important ways to control a disease outbreak. It should be complete and thorough. Laxity in quarantine is dangerous. Not only should sick and exposed animals be segregated, but all traffic of attendants and vehicles between them and healthy animals must be stopped. If it is necessary for the same attendant to look after both sick and well animals, clothing should be changed and shoes especially should be cleaned and disinfected before attendant leaves infected premises. All dogs should be confined while dangerous diseases are present in a community. Residents of the neighborhood should be warned of the existence of such diseases and a notification sign placed at the entrance of the farm. When one or more animals show symptoms of serious ailment, the exact cause of which is unknown, it is always advisable to remove other susceptible animals from possible exposure, as a precautionary measure.

Medicinal Treatment.—Medicine may be administered in a number of ways. The channel and method of administration depend upon the kind and the condition of the animal, the nature of the medicine, and whether a local or general effect is desired. The easiest method, and therefore the most common, is to give ordinary remedies by the mouth with the food, with drink, or separately. There are, however, some conditions in which medicines given in this way will not act promptly enough or wherein a desired effect on a distant part of the body is wholly lacking unless administered in some other manner. It is very probable that more animals are killed by the improper administration of medicines, in the hands of unskilled persons, than would be lost if no attempt at all had been made to treat them.

Other methods of administering medicines are by the nostril, rectum, vagina, udder, skin, injection under the skin, and veins.

Sanitation and Farm Hygiene.—The surest precautions against the introduction of livestock diseases on a farm are as follows:

(1) Exercise every effort to procure disease-free stock for breeding and feeding purposes.

(2) Keep animals healthy by providing clean and sanitary surroundings.

(3) Feed them nutritious feeds and supply plenty of pure water and fresh air.

(4) When making additions to herds or flocks, place new animals in quarantine for a few weeks before allowing them to associate with other farm stock.

(5) Thoroughly clean and disinfect barns, lots, and sheds used by farm animals, at periodic intervals.

(6) Refrain from visiting other farms where disease is known to exist.

(7) In infected areas, keep livestock protected against certain diseases, such as hog cholera, blackleg, and anthrax, by immunization.

(8) Place cattle herds under supervision of livestock sanitary officials or qualified practicing veterinarians for the eradication of such diseases as tuberculosis, foot-and-mouth disease, and infectious abortion.

Shipping Specimens for Identification.—When animals die from an unknown cause it may be desirable to send parts of the body, or the whole body of fowls and small

animals, to officials or laboratories for examination. The part selected for shipment will depend upon the nature of the disease. For example, in blood diseases a part of the ear is satisfactory, and in other conditions some of the internal organs may be chosen. Such material should be placed in a clean metal container, and packed in a sufficient quantity of absorbent material to take up any liquids, and the container protected against damage from breakage. Label each specimen with a description of what it is, and include the name and address of the person sending it. Accompany each shipment with a separate letter giving full information regarding the history of the disease and of the animal, symptoms shown, post-mortem evidences, number of animals sick and dead, and anything else bearing on the case. Parts to be sent should be procured as soon after death of the animal as possible. Great care should be used in cutting into and handling the bodies of dead animals on account of the danger of human beings contracting disease. This danger is too great to chance with such a disease as anthrax.

MISCELLANEOUS 5.9

Normal pulse, respiration, and temperature table for mature animals

Animal	Pulse	Respiration	Temperature
	Per minute	*Per minute*	°*F.*
Cattle	45 to 55	12 to 18	101. 8 to 102. 0
Dog	90 to 100	15	99. 5 to 103. 0
Goat	70 to 80	12 to 20	101. 3 to 105. 8
Hog	70 to 80	15 to 20	100. 9 to 105. 4
Horse	32 to 40	8 to 14	99. 5 to 101. 0
Sheep	70 to 80	12 to 20	101. 3 to 105. 8

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.31 Sheep—Continued.
.311 Fine-wool type.
.3111 American Merino.
.3112 Rambouillet.
.3119 Miscellaneous.
.312 Medium-wool type.
.3121 Cheviot.
.3122 Dorset Horn.
.3123 Hampshire.
.3124 Oxford.
.3125 Shropshire.
.3126 Southdown.
.3127 Suffolk.
.3129 Miscellaneous.
.313 Long-wool type.
.3131 Cotswold.
.3132 Leicester.
.3133 Lincoln.
.3134 Romney Marsh.
.3139 Miscellaneous.
.314 Crossbred type.
.3141 Columbia.
.3142 Corriedale.
.3149 Miscellaneous.
.319 Miscellaneous.
.32 Goats.
.320 General.
.321 Angora.
.322 Milk.
.3221 Nubian.
.3222 Saanen.
.3223 Toggenburg.
.3229 Miscellaneous.
.329 Miscellaneous.
.33 Breeding.
.330 General.
.331 Purebred industry.
.3310 General.
.3311 Methods.
.3312 Standards.
.3319 Miscellaneous.
.332 Mutton and lamb production.
.3320 General.
.3321 Methods.
.3322 Standards.
.3329 Miscellaneous.
.339 Miscellaneous.
.34 Feeding.
.340 General.
.341 Feeds.
.3411 Concentrates.
.3412 Dry roughage.
.3413 Pasture.
.3414 Succulents.
.3419 Miscellaneous.
.342 Mineral requirements.
.343 Rations.
.3431 Breeding.
.3432 Fattening.
.3433 Growing.
.3439 Miscellaneous.
.344 Water.
.349 Miscellaneous.
.35 Management.
.350 General.
.351 Castration.
.352 Docking.

.3 Sheep and goats—Continued.
.35 Management—Continued.
.353 Equipment. (See 3.7.)
.3531 Lots, creeps, fences.
.3532 Shelter.
.3533 Self-feeders, racks, troughs.
.3539 Miscellaneous.
.354 Flushing.
.355 Identification (brands, tags).
.356 Lambing.
.357 Sanitation. (See 5.)
.358 Shearing.
.359 Miscellaneous.
.36 Marketing.
.360 General.
.361 Breeding stock.
.362 Commercial stock.
.363 Mohair.
.364 Wool.
.369 Miscellaneous.
.37 Farm mutton supply.
.370 General.
.371 Slaughter.
.372 Preparation.
.373 Utilization.
.379 Miscellaneous.
.39 Miscellaneous.
.4 Hogs.
.40 General.
.401 Associations.
.402 Exhibit classification.
.403 Score cards.
.409 Miscellaneous.
.41 Lard type.
.410 General.
.411 Berkshire.
.412 Big Black pig.
.413 Chester White.
.414 Duroc-Jersey.
.415 Hampshire.
.416 Mule-foot.
.417 Poland China.
.418 Spotted Poland China.
.419 Miscellaneous.
.4191 Cheshire.
.4192 Essex.
.42 Bacon type.
.420 General.
.421 Tamworth.
.422 Yorkshire.
.429 Miscellaneous.
.43 Breeding.
.430 General.
.431 Purebred industry.
.4310 General.
.4311 Methods.
.4312 Standards.
.4319 Miscellaneous.
.432 Pork production.
.4320 General.
.4321 Methods.
.4322 Standards.
.4329 Miscellaneous.
.439 Miscellaneous.

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.4 Hogs—Continued.
.44 Feeding.
.440 General.
.441 Feeds.
.4411 By-products.
.4412 Concentrates.
.4413 Forage.
.4414 Garbage.
.4415 Roughage.
.4419 Miscellaneous.
.442 Mineral requirements.
.443 Rations.
.4431 Breeding.
.4432 Fattening.
.4433 Growing.
.4439 Miscellaneous.
.444 Water.
.449 Miscellaneous.
.45 Management.
.450 General.
.451 Castration.
.452 Equipment. (See 3.7.)
.4521 Breeding crate.
.4522 Fences, lots, loading chutes.
.4523 Fountains and oilers.
.4524 Shelter.
.4525 Self-feeders, racks, creeps, troughs.
.4529 Miscellaneous.
.453 Identification (tags, marks).
.454 Sanitation. (See 5.)
.459 Miscellaneous.
.46 Marketing.
.460 General.
.461 Breeding stock.
.462 Commercial stock.
.469 Miscellaneous.
.47 Farm pork supply.
.470 General.
.471 Slaughter.
.472 Cutting.
.473 Curing.
.479 Miscellaneous.
.49 Miscellaneous.
.5 Poultry.
.50 General.
.501 Standard Bred industry.
.5010 General.
.5011 Associations.
.5012 Score cards.
.5019 Miscellaneous.
.502 Egg and poultry-meat industry.
.5020 General.
.5021 Back-yard.
.5022 Commercial.
.5023 Farm.
.5029 Miscellaneous.
.51 Chickens.
.510 General.
.511 American class.
.5111 Buckeye.
.5112 Dominique.
.5113 Java.
.5114 Jersey Black Giant.
.5115 Plymouth Rock.
.5116 Rhode Island Red.

5 Poultry—Continued.
.51 Chickens—Continued.
.511 American class—Continued.
.5117 Rhode Island White.
.5118 Wyandotte.
.5119 Miscellaneous.
.51191 Chantecler.
.512 Mediterranean class.
.5121 Ancona.
.5122 Black Spanish.
.5123 Blue Andalusian.
.5124 Leghorn.
.5125 Minorca.
.5126 White-faced.
.5129 Miscellaneous.
.513 Continental class.
.5131 Buttercup.
.5132 Campine.
.5139 Miscellaneous.
.514 Asiatic class.
.5141 Brahma.
.5142 Cochin.
.5143 Langshan.
.5149 Miscellaneous.
.515 English class.
.5151 Cornish.
.5152 Dorking.
.5153 Orpington.
.5154 Redcap.
.5155 Sussex.
.5159 Miscellaneous.
.516 French class.
.5161 Crèvecœur.
.5162 Faverolles.
.5163 Houdan.
.5164 La Flèche.
.5169 Miscellaneous.
.517 Ornamental class.
.5171 Frizzle.
.5172 Game.
.5173 Hamburg.
.5174 Malay.
.5175 Polish.
.5176 Sultan.
.5177 Sumatra.
.5179 Miscellaneous.
.518 Bantam.
.5181 Brahma.
.5182 Cochin.
.5183 Game.
.5184 Japanese.
.5185 Malay.
.5186 Polish.
.5187 Sebright.
.5188 Silky.
.5189 Miscellaneous.
.519 Miscellaneous.
.52 Ducks.
.520 General.
.521 Egg class.
.5211 Indian Runner.
.5219 Miscellaneous.
.522 Meat class.
.5221 Aylesbury.
.5222 Buff.
.5223 Cayuga.
.5224 Muscovy.

.5 Poultry—Continued.
.52 Ducks—Continued.
.522 Meat class—Continued.
.5225 Pekin.
.5226 Rouen.
.5227 Swedish.
.5229 Miscellaneous.
.523 Ornamental class.
.5231 Black East India.
.5232 Call.
.5233 Crested White.
.5239 Miscellaneous.
.529 Miscellaneous.
.53 Geese.
.530 General.
.531 Breed.
.5311 African.
.5312 Canadian or wild.
.5313 Chinese.
.5314 Egyptian.
.5315 Embden.
.5316 Toulouse.
.5219 Miscellaneous.
.53191 Mongrel.
.53192 Sebastopol.
.539 Miscellaneous.
.54 Turkeys.
.540 General.
.541 Variety.
.5411 Black.
.5412 Bourbon Red.
.5413 Bronze.
.5414 Narragansett.
.5415 Slate.
.5416 White Holland.
.5419 Miscellaneous.
.549. Miscellaneous.
.55 Breeding.
.550 General.
.551 Standards.
.552 Systems.
.559 Miscellaneous.
.56 Feeding.
.560 General.
.561 Feeds.
.5611 By-products.
.5612 Grain.
.5613 Green.
.56131 Cultivated.
.56132 Free range.
.56139 Miscellaneous.
.5614 Mash.
.56141 Dry.
.56142 Wet.
.56149 Miscellaneous.
.5619 Miscellaneous.
.562 Mineral requirements.
.5621 Grit.
.5622 Lime.
.5623 Charcoal.
.5629 Miscellaneous.
.563 Rations.
.5631 Breeding.
.5632 Fattening.
.5633 Growing chick feed.
.5634 Laying.
.5639 Miscellaneous.
.564 Water.
.569 Miscellaneous.

.5 Poultry—Continued.
.57 Management.
.570 General.
.571 Brooding.
.572 Caponizing.
.573 Culling.
.574 Equipment. (See 3.7.)
.5741 Artificial lighting.
.5742 Dust and grit box.
.5743 Fountains.
.5744 Incubators.
.5745 Roosts, nests.
.5746 Self feeders, troughs.
.5747 Shelter.
.57471 Brooder.
.57472 House.
.57473 Shade.
.57479 Miscellaneous.
.5748 Yards, fences, hurdles.
.5749 Miscellaneous.
.575 Identification (band, tag, punch).
.576 Incubation.
.577 Sanitation. (See 5.)
.579 Miscellaneous.
.58 Marketing.
.580 General.
.581 Baby chicks.
.582 Breeding stock.
.583 Dressed poultry.
.5831 Drawing.
.5832 Dry picking.
.5833 Killing.
.5834 Packing.
.5835 Scalding.
.5839 Miscellaneous.
.584 Eggs.
.5841 Hatching.
.5842 Market.
.58421 Candling.
.58422 Packing.
.58423 Preservation.
.58429 Miscellaneous.
.5849 Miscellaneous.
.585 Live poultry.
.589 Miscellaneous.
.59 Miscellaneous.
.591 Canaries.
.592 Guinea fowl.
.5921 Variety.
.59211 Lavender.
.59212 Pearl.
.59213 White.
.59219 Miscellaneous.
.593 Parrots.
.594 Peafowl.
.595 Pigeons.
.5941 Variety.
.59511 Carneau.
.59512 Homer.
.59513 Maltese.
.59514 Runt.
.59515 Swiss Mondaine.
.59516 White King.
.59519 Miscellaneous.

.8 Regulatory work.
.80 General.
.81 Animal comfort requirements.
.810 General.
.811 28-hour law.
.819 Miscellaneous.
.82 Disease-control requirements.
.820 General.
.821 Certification of health.
.829 Miscellaneous.
.89 Miscellaneous.
.9 Miscellaneous.
.91 Cats.
.92 Dogs.
.93 Experimental animals.
.930 General.
.931 Guinea pigs.
.932 Mice.
.933 Rabbits.
.934 Rats.
.939 Miscellaneous.
.99 Bibliography of literature on animal husbandry.
.991 Books.
.992 Bulletins, circulars.
.993 Periodicals.

ANIMAL HUSBANDRY

GENERAL

Livestock on farms and elsewhere

[Bureau of Census]

State	Horses, Jan. 1, 1925 (number)	All cattle, Jan. 1, 1925 (number)	Sheep, Jan. 1, 1920 (number)	Hogs, Jan. 1, 1925 (number)	Poultry, Jan. 1, 1920 (number)
Ala	87, 308	840, 030	81, 868	845, 063	6, 266, 756
Ariz	111, 902	1, 063, 692	881, 914	20, 992	517, 312
Ark	188, 062	836, 557	100, 159	857, 098	7, 395, 654
Calif	316, 831	1, 907, 803	2, 400, 151	405, 261	10, 811, 183
Colo	367, 191	1, 465, 364	1, 813, 255	492, 912	2, 994, 347
Conn	34, 060	155, 285	10, 842	17, 017	1, 153, 667
Del	20, 401	46, 160	3, 220	24, 106	1, 000, 287
Dist of Col	249	907	10	999	11, 066
Fla	30, 938	662, 215	64, 659	505, 768	1, 622, 437
Ga	55, 785	938, 689	72, 173	1, 274, 556	7, 621, 158
Idaho	236, 119	609, 180	2, 356, 270	276, 315	1, 711, 884
Ill	1, 032, 058	2, 345, 224	637, 685	4, 363, 379	25, 864, 558
Ind	557, 478	1, 296, 164	643, 889	3, 006, 444	17, 147, 576
Iowa	1, 191, 954	4, 372, 298	1, 092, 095	8, 687, 001	28, 352, 515
Kans	938, 417	3, 143, 171	361, 102	2, 239, 052	17, 298, 041
Ky	313, 588	937, 779	707, 845	932, 237	11, 020, 231
La	131, 748	703, 245	129, 816	527, 955	4, 010, 782
Me	82, 094	238, 352	119, 471	54, 430	1, 418, 342
Md	116, 761	278, 354	103, 027	201, 843	3, 688, 566
Mass	43, 537	192, 131	18, 880	63, 810	1, 517, 477
Mich	495, 699	1, 416, 535	1, 209, 191	905, 647	11, 183, 064
Minn	837, 004	2, 863, 424	509, 064	2, 795, 343	13, 663, 443
Miss	141, 952	938, 024	164, 440	729, 165	6, 698, 846
Mo	714, 163	2, 442, 004	1, 271, 616	3, 592, 492	25, 610, 515
Mont	596, 055	1, 339, 847	2, 082, 919	279, 695	2, 127, 854
Nebr	863, 173	3, 314, 373	573, 217	4, 280, 009	11, 932, 243
Nev	50, 490	417, 531	880, 580	26, 585	163, 984
N. H	31, 457	121, 064	28, 021	16, 728	782, 775
N. J	57, 123	156, 397	10, 471	56, 454	2, 665, 662
N. M	187, 721	1, 289, 636	1, 640, 475	58, 647	739, 782
N. Y	446, 747	1, 850, 776	578, 726	270, 190	10, 759, 268
N. C	129, 800	544, 512	90, 556	894, 170	7, 827, 935
N. Dak	731, 572	1, 344, 956	298, 912	788, 296	4, 608, 449
Ohio	634, 978	1, 674, 541	2, 102, 550	2, 420, 919	20, 604, 103
Okla	614, 206	1, 694, 616	105, 370	968, 944	11, 614, 851
Oreg	225, 358	796, 231	2, 002, 378	223, 080	2, 573, 536
Pa	416, 208	1, 340, 451	508, 711	782, 256	15, 226, 961
R. I	5, 368	27, 203	2, 736	4, 175	266, 009
S. C	49, 259	340, 151	23, 581	538, 839	4, 240, 009
S. Dak	720, 282	2, 073, 758	843, 696	2, 611, 946	6, 968, 088
Tenn	254, 739	1, 022, 708	364, 196	1, 035, 494	11, 835, 303
Tex	841, 247	5, 800, 981	2, 573, 485	1, 168, 981	19, 024, 124
Utah	110, 314	507, 350	1, 691, 795	64, 076	980, 097
Vt	62, 819	393, 321	62, 756	43, 864	815, 085
Va	261, 471	826, 645	342, 367	583, 852	8, 286, 676
Wash	242, 373	585, 763	623, 779	197, 945	3, 614, 475
W. Va	143, 083	586, 776	509, 831	179, 155	4, 179, 658
Wis	617, 744	3, 035, 131	479, 991	1, 427, 449	11, 762, 273
Wyo	196, 873	794, 447	1, 859, 775	101, 794	646, 357
Total	16,535,759	61,571,752	35,033,516	51,842,428	372, 825, 264

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Breeding table

Animal	Periods of puberty: Average age (months)	Periods of puberty: Best age to breed (months)	Oestrus (heat): Duration	Oestrus (heat): Repeats	Oestrus (heat): Occurs after parturition	Oestrus (heat): Time to breed after delivery
Jennet	12	24 to 36	3 to 7 days	3 weeks	3 to 17 days	9th day.
Mare	10	24 to 36	3 to 7 days	3 weeks	3 to 17 days	9th day.
Cow	10	18 to 24	3 to 48 hours	3 weeks	28 days	6 to 8 weeks.
Sow	6	9 to 10	1 to 5 days	3 weeks	3 to 9 days	8½ weeks.
Ewe	6	18 to 20	1 to 3 days	13 to 19 days.	6 to 7 months.	Summer and fall.

Gestation.—The period of gestation for animals of the same kind varies to some extent, but the following are about the averages:

	Days	Months
Mare	340	(11)
Jennet	365	(12)
Cow	283	(9½)
Ewe	150	(5)
Goat	150	(5)
Sow	114	(4)

Gestation table

Date of service[1]	Probable date of birth: Sow	Ewe	Cow	Mare
Jan. 1	Apr. 25	May 31	Oct. 11	Dec. 7
Jan. 16	May 10	June 15	Oct. 26	Dec. 22
Feb. 1	May 26	July 1	Nov. 11	Jan. 7
Feb. 16	June 11	July 16	Nov. 26	Jan. 22
Mar. 1	June 23	July 29	Dec. 9	Feb. 4
Mar. 16	July 8	Aug. 13	Dec. 24	Feb. 19
Apr. 1	July 24	Aug. 29	Jan. 9	Mar. 7
Apr. 16	Aug. 8	Sept. 13	Jan. 24	Mar. 22
May 1	Aug. 23	Sept. 28	Feb. 8	Apr. 6
May 16	Sept. 7	Oct. 13	Feb. 23	Apr. 21
June 1	Sept. 23	Oct. 29	Mar. 11	May 7
June 16	Oct. 8	Nov. 13	Mar. 26	May 22
July 1	Oct. 23	Nov. 28	Apr. 10	June 6
July 16	Nov. 7	Dec. 13	Apr. 25	June 21
Aug. 1	Nov. 23	Dec. 29	May 11	July 7
Aug. 16	Dec. 8	Jan. 13	May 26	July 22
Sept. 1	Dec. 24	Jan. 29	June 11	Aug. 7
Sept. 16	Jan. 8	Feb. 13	June 26	Aug. 22
Oct. 1	Jan. 23	Feb. 28	July 11	Sept. 6
Oct. 16	Feb. 7	Mar. 15	July 26	Sept. 21
Nov. 1	Feb. 23	Mar. 31	Aug. 11	Oct. 7
Nov. 16	Mar. 10	Apr. 15	Aug. 26	Oct. 22
Dec. 1	Mar. 25	Apr. 30	Sept. 10	Nov. 6
Dec. 16	Apr. 9	May 15	Sept. 25	Nov. 21

[1] The table gives the probable date of birth of young when the females are bred on the first or sixteenth day of the month. If the date of service is for instance 3, 5, 9, or 12 days after these dates, simply add the same number of days to date of expectation.

Mating table, showing number of females to each male

Animal	Number of matings
Horses:	
2-year-old stallion	10
3-year-old stallion	30
4-year-old stallion	35 to 40
5-year-old stallion	40 to 75
Cattle:	
Yearling bull	20
2-year-old or over	40 to 75
Hogs:	
Boar pig	5 to 20
Yearling boar	20 to 30
Mature boar	35 to 40
Sheep or goats:	
Ram lamb or buck kid (only to test)	5 to 8
Ram or buck 18 months old or over	30 to 50

Principles of Feeding

Definition of Terms—*Concentrates.*—Feeds such as grains, cottonseed meal, and tankage which are rich and concentrated and supply a large quantity of feed per unit weight.

Roughages.—Feeds such as hay, straw, roots, and silage which are coarse and bulky in nature.

Legumes.—Plants such as clover, alfalfa, cowpeas, and soy beans which have nodules on their roots containing bacteria that can take nitrogen from the air. Legumes are generally richer in protein and minerals than other roughages.

Nutrients.—Substances in feeds which nourish animals.

Protein.—The only nutrient which can produce growth and make repairs in the animal's body. Lean meat, skim milk, wheat bran, cottonseed meal, and tankage are some of the feeds which contain relatively large quantities of protein.

Carbohydrates and fat.—Nutrients which produce fat, heat, and power to do work in the animal's body. Fat is about two and one-fourth times as valuable for these uses as carbohydrates. Feeds containing large quantities of starch and sugar are rich in carbohydrates, while large quantities of fat are contained in oily feeds. Corn is rich in both carbohydrates and fat.

Mineral matter.—Nutrients used principally to build the skeleton, hair, hoof, horn, and the like. Legume hays, bran, linseed meal, and skim milk have relatively large quantities of mineral matter.

Vitamins.—Substances found in feeds in very small quantities which are necessary for growth, reproduction, and protection against diseases such as scurvy.

Crude fiber.—The coarse, woody part of plants and one of the carbohydrates much less digestible than the others.

Ration.—The quantity of feed given an animal during one day.

Balanced ration.—A ration which contains the proportion of nutrients properly to nourish the animal to which it is fed.

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Nutritive ratio.—Nutritive ratio is the relation that exists between the digestible protein on the one hand, and the digestible carbohydrates and digestible fat on the other, after the fat has been multiplied by 2¼. For example, the digestible nutrient content of corn is, protein 7.5 pounds in 100, carbohydrates 67.8, and fat 4.6 pounds. The nutritive ratio of corn, then, is

$$\frac{67.8+(2\tfrac{1}{4}\times 4.6)}{7.5}=\frac{10.4}{1},$$

or 1 : 10.4, or the ratio of the protein to the combined carbohydrates and fat is as 1 is to 10.4. A ration is considered wide when the nutritive ratio is as 1 : 8 or greater; medium when the ratio is as 1 : 5 to 7; and narrow when the ratio is as 1 : 4 or less.

Weights and Measures of Common Feeds.—In calculating rations it is usually necessary to use weights rather than measures. However, it is often easier to measure concentrates. The following table makes this possible:

Weights of common feeds in pounds per quart (dry measure) and per bushel

Feed	Weight of 1 quart (approximate to ¼ pound)	Approximate weight of 1 bushel
	Pounds	*Pounds*
Alfalfa feed	¾	25
Barley	1½	48
Beet pulp (dried)	½	19
Brewers' grains (dried)	½	19
Buckwheat	1½	50
Buckwheat bran	1	29
Charcoal	½	20
Corn, husked, ear	----------	70
Corn, cracked	1½	50
Corn, shelled	1¾	56
Corn meal	1½	50
Corn-and-cob meal	1½	45
Cottonseed meal	1½	48
Cowpeas	2	60
Distillers' grains (dried)	½	19
Fish meal	1	35
Gluten feed	1¼	42
Linseed meal (old process)	1	29
Linseed meal (new process)	1	35
Meat scrap	1¼	42
Molasses feed	¾	26
Oats	1	32
Oats, ground	¾	22
Oat middlings	1½	48
Peanut meal	1	29
Rice bran	¾	26
Rye	1¾	56
Soy beans	1¾	62
Tankage	1¼	40
Velvet beans, shelled	1½	60
Wheat	2	60
Wheat bran	½	19
Wheat middlings, standard	¾	26
Wheat screenings	1	32

Analyses of Feeds.—The analyses and digestible nutrients of some common feeds listed below have been compiled by the United States Department of Agriculture. The carbohydrate equivalent shown in the last column of the table is the sum of the digestible crude fiber and nitrogen-free extract, plus 2.25 times the digestible fat.

Analyses of feeds

Feed	Moisture	Ash	Crude protein	Carbohydrates		Fat, or ether extract	Digestible protein	Digestible carbohydrate equivalent
				Crude fiber	Nitrogen-free extract			
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Cereal grains:								
Barley	9.6	2.9	12.8	5.5	66.9	2.3	10.4	63.8
Buckwheat	12.6	2.0	10.0	8.7	64.5	2.2	8.1	63.2
Corn	12.9	1.3	9.3	1.9	70.3	4.3	7.1	74.8
Ground ear corn	15.6	1.5	8.3	6.8	64.4	3.4	4.3	66.2
Kafir corn	9.4	1.6	11.1	2.1	72.6	3.2	6.2	54.1
Oats	7.7	3.5	12.5	11.2	60.7	4.4	9.7	56.6
Wild oats	7.5	4.7	9.5	17.9	54.3	6.1	7.4	56.3
Rice (polished)	12.4	.4	7.4	.2	79.2	.4	5.9	66.5
Rye	9.5	1.9	11.1	2.1	73.7	1.7	8.3	64.7
Sorghum seed	12.8	2.1	9.1	2.6	69.8	3.6	5.1	52.7
Wheat	10.6	1.8	12.3	2.4	71.1	1.8	9.8	63.3
Cereal products:								
Buckwheat middlings	11.5	4.5	27.5	4.2	45.3	7.0	23.4	52.3
Brewers' dried grains	6.8	3.6	26.9	14.3	41.4	7.0	21.8	44.6
Corn gluten feed	9.2	3.6	25.1	7.3	51.9	2.9	21.3	57.7
Corn gluten meal	9.0	1.3	40.9	3.2	44.5	1.1	36.0	44.3
Corn germ meal	7.0	3.8	20.8	7.3	51.5	9.6	15.2	65.4
Corn bran	10.3	2.4	9.9	10.4	59.7	7.3	5.3	64.8
Corn feed meal	10.8	1.5	8.8	2.3	72.7	3.9	6.7	76.5
Distillers' dried grains	6.9	3.2	19.7	15.6	46.4	8.2	14.4	69.9
Elevator dust	7.5	18.3	10.6	15.0	45.3	3.3	7.1	39.7
Hominy feed	8.3	2.9	10.9	4.6	65.6	7.7	7.1	77.4
Malt	7.7	2.9	12.4	6.0	68.9	2.1	9.1	66.0
Malt sprouts	7.8	5.7	25.9	12.4	46.9	1.3	19.7	54.7
Oat clips	9.0	9.3	11.8	22.7	42.7	4.5	7.7	34.3
Oat hulls	7.2	7.1	2.6	34.5	48.0	.6	1.7	32.4
Oatmeal mill by-products	6.9	6.4	6.5	26.0	52.3	1.9	4.2	34.1
Red-dog flour	10.1	2.9	17.2	3.1	61.9	4.8	13.6	57.6
Rice bran	9.6	10.0	13.8	11.3	40.5	14.8	9.4	60.4
Rice hulls	7.9	19.5	2.7	41.3	27.8	.8	.2	11.7
Rice polish	9.4	5.0	12.1	2.1	61.7	9.7	8.1	74.6
Rye feed	10.2	4.0	15.6	4.3	62.7	3.2	12.6	63.1
Rye middlings	9.5	4.4	16.7	5.5	60.2	3.7	13.5	61.5
Rye middlings and screenings	9.1	4.9	16.2	6.5	59.6	3.7	13.1	61.1
Screenings	8.0	6.4	15.0	9.7	57.1	3.8	9.7	53.4
Vinegar grains	6.8	2.9	19.5	17.3	46.5	7.0	14.2	69.1
Wheat bran	9.6	5.9	16.2	8.5	55.6	4.2	12.5	48.7
Wheat bran and screenings	9.1	6.4	15.9	9.0	55.5	4.1	12.2	48.7

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Analyses of feeds—Continued

Feed	Moisture	Ash	Crude protein	Carbohydrates: Crude fiber	Carbohydrates: Nitrogen-free extract	Fat, or ether extract	Digestible protein	Digestible carbohydrate equivalent
Cereal products—Con.	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Wheat middlings or shorts	10.1	3.5	16.3	4.3	61.6	4.2	13.2	60.1
Wheat middlings and ground screenings	9.4	4.9	16.9	6.1	58.0	4.7	13.7	58.7
Wheat mixed feed	9.7	5.0	16.2	6.7	58.1	4.3	12.6	57.3
Wheat mixed feed and screenings	9.8	5.4	16.3	6.6	57.7	4.2	12.7	56.7
Cereal and sorghum hay, stover, and fodder:								
Barley hay	10.6	5.3	9.3	23.6	48.7	2.5	6.0	47.6
Corncobs	10.7	1.4	2.4	30.1	54.9	.5	.4	53.1
Corn fodder	11.8	5.8	7.4	23.0	49.6	2.4	4.1	55.6
Corn husks	9.8	2.9	2.9	30.7	53.0	.7	.3	54.0
Corn leaves	11.8	8.5	8.1	24.4	45.0	2.2	4.5	53.0
Cornstalks	11.7	4.6	4.8	32.7	44.4	1.8	1.7	49.8
Corn stover	10.7	6.1	5.7	30.3	45.7	1.5	2.1	48.6
Kafir fodder	9.1	7.8	6.6	28.4	46.0	2.1	2.4	48.9
Millet	10.3	7.9	8.8	27.0	43.3	2.7	5.1	48.3
Oat hay	11.0	6.8	7.9	29.6	41.9	2.8	4.2	41.7
Rye hay	6.4	4.7	5.9	37.4	43.6	2.0	3.1	45.4
Sorghum hay	5.8	9.5	9.5	26.8	46.5	1.9	3.5	48.0
Cereal and legume straw:								
Barley	14.2	5.7	3.5	36.0	39.1	1.5	.7	42.6
Buckwheat	9.9	5.5	5.2	43.0	35.1	1.3	2.8	40.8
Oat	9.2	5.1	4.0	37.0	42.4	2.3	1.2	40.3
Peanut	9.5	9.3	9.9	23.9	43.6	3.8	6.2	49.1
Rye	7.1	3.2	3.0	38.9	46.6	1.2	.6	41.4
Soy bean	8.7	7.4	5.7	34.6	41.1	2.5	2.8	41.2
Sweet clover	5.1	3.4	6.7	49.6	34.0	1.2	5.0	42.2
Wheat	9.6	4.2	3.4	38.1	43.4	1.3	.4	37.2
Grass hays:								
Black grama	5.5	7.0	4.3	31.4	50.5	1.3	2.5	44.7
Italian rye grass	8.5	6.9	7.5	30.5	44.9	1.7	3.3	47.5
Johnson grass	9.0	7.0	8.2	29.7	43.4	2.7	3.6	47.1
Orchard grass	9.9	6.0	8.1	32.4	41.0	2.6	4.9	45.5
Redtop	8.9	5.2	7.9	28.6	47.5	1.9	4.8	49.1
Sudan grass	5.3	8.1	9.7	27.9	47.3	1.7	4.8	44.2
Swamp	11.6	6.7	7.2	26.6	45.9	2.0	3.0	43.4
Timothy	12.5	5.4	6.8	28.3	44.3	2.7	3.3	44.7
Oil-bearing and legume seeds:								
Cottonseed	9.1	4.0	19.6	18.9	28.3	20.1	15.5	72.5
Cowpeas	9.8	3.6	23.8	4.3	57.1	1.4	19.5	58.2
Peanut kernels	5.5	2.3	30.2	2.8	11.6	47.6	28.4	116.7
Peanuts (hulls on)	6.0	2.8	24.7	18.0	15.4	33.1	23.2	90.9
Soy beans	6.4	4.8	39.1	5.2	25.8	18.7	35.6	60.4
Sunflower	6.2	4.2	15.9	28.6	21.1	24.0	12.6	81.1
Velvet beans (pods on)	9.2	4.8	17.6	14.3	49.7	4.4	13.0	56.3
Velvet beans	9.8	3.1	26.2	6.0	50.1	4.8	21.5	58.4

Analyses of feeds—Continued

Feed	Moisture	Ash	Crude protein	Carbohydrates: Crude fiber	Carbohydrates: Nitrogen-free extract	Fat, or ether extract	Digestible protein	Digestible carbohydrate equivalent
Meals, cakes, and feeds from oil-bearing and legume seeds:	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Coconut meal (old process)	7.3	5.5	21.3	9.4	46.5	10.0	19.2	65.1
Coconut meal (new process)	8.9	6.6	21.4	13.3	47.4	2.4	19.3	49.9
Cottonseed meal (cold pressed)	6.9	4.2	27.5	24.2	30.2	7.0	20.3	42.2
Cottonseed meal (choice)	7.1	5.7	41.7	10.0	28.4	7.1	35.0	40.7
Cottonseed meal (prime)	6.9	5.9	38.8	12.2	29.4	6.8	32.6	41.6
Cottonseed meal (good)	7.3	5.8	36.8	13.5	30.0	6.6	30.9	42.1
Cottonseed feed	8.3	4.8	32.1	15.3	33.1	6.4	27.0	44.7
Cottonseed hulls	8.7	2.6	3.5	46.2	38.0	1.0	.2	36.4
Linseed meal (old process)	3.9	5.4	34.5	7.7	36.7	6.8	30.7	46.6
Peanut meal (high grade)	6.2	4.9	49.3	6.3	22.5	10.8	46.3	45.0
Peanut meal (low grade)	7.4	6.6	27.9	20.3	28.8	9.0	26.2	49.4
Peanut meal (whole pressed)	7.8	4.7	35.3	21.4	21.8	9.0	33.2	43.5
Peanut hulls	7.5	4.3	6.8	60.7	19.6	1.1	3.5	20.9
Soy-bean meal	6.1	5.6	47.1	5.7	27.7	7.8	42.9	39.7
Velvet-bean pods with a few stems	9.4	4.9	4.9	29.0	51.1	.7	3.6	59.8
Legume hays:								
Alfalfa	8.3	8.9	16.0	27.1	37.1	2.6	11.5	42.0
Alsike clover	10.5	8.8	14.4	24.7	39.1	2.5	9.5	40.3
Cowpea	9.7	12.9	17.5	20.5	36.6	2.8	11.9	37.0
Crimson clover	9.6	8.6	15.2	27.2	36.6	2.8	10.5	37.7
Field pea	10.6	8.3	16.1	24.8	37.5	2.7	12.6	45.3
Lespedeza	7.9	6.2	11.9	28.5	42.7	2.8	7.9	44.8
Mammoth clover	12.2	7.5	12.8	27.1	37.1	3.3	7.8	43.2
Red clover	12.9	6.9	13.6	24.1	39.1	3.4	8.3	43.2
Sweet clover	8.1	7.5	16.2	25.9	39.5	2.8	12.1	39.2
Soy bean	8.4	8.9	15.8	24.3	38.8	3.8	11.2	44.0
Vetch	11.3	7.9	17.0	25.4	36.1	2.3	11.6	43.4
Packing-house and animal products:								
Bone meal	7.2	61.5	23.1	3.3	-----	4.9	16.0	11.7
Fish meal	6.8	18.5	59.3	.6	2.6	12.2	54.2	27.7
Meat scrap	7.1	21.1	53.9	2.2	5.0	10.7	50.1	29.0
Tankage	7.6	22.2	53.7	1.8	3.8	10.9	37.1	27.1
Mik and its products:								
Whole milk	87.1	.7	3.6	-----	4.9	3.7	3.4	13.2
Skim milk by setting	90.4	.7	3.3	-----	4.7	.9	3.1	6.7
Skim milk by separator	90.6	.7	3.2	-----	5.2	.3	3.0	5.9
Buttermilk	91.0	.7	3.0	-----	4.8	.5	2.8	5.9
Whey	93.8	.4	.6	-----	5.1	.1	.6	5.3

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Analyses of feeds—Continued

Feed	Moisture	Ash	Crude protein	Carbohydrates: Crude fiber	Carbohydrates: Nitrogen-free extract	Fat, or ether extract	Digestible protein	Digestible carbohydrate equivalent
Green forage (legumes not included):	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Corn fodder—								
Dent (immature)	79.0	1.2	1.7	5.6	12.0	.5	1.1	12.9
Dent (mature)	73.4	1.5	2.0	6.7	15.5	.9	1.1	16.6
Flint (immature)	79.8	1.1	2.0	4.3	12.1	.7	1.3	12.5
Flint (mature)	77.1	1.1	2.1	4.3	14.6	.8	1.1	14.8
Hungarian grass	71.1	1.7	3.1	9.2	14.2	.7	1.4	13.5
Italian rye grass	73.0	2.5	3.1	6.8	13.3	1.3	.8	13.2
Kafir	73.0	2.0	2.3	6.9	15.1	.7	1.5	16.3
Kentucky blue grass	65.1	2.8	4.1	9.1	17.6	1.3	2.0	17.4
Meadow fescue	69.9	1.8	2.4	10.8	14.3	.8	1.2	15.6
Oats	62.2	2.5	3.4	11.2	19.3	1.4	2.5	20.3
Orchard grass	73.0	2.0	2.6	8.2	13.3	.9	1.5	12.4
Rape	85.7	2.0	2.4	2.2	7.1	.6	2.1	9.1
Redtop	65.3	2.3	2.8	11.0	17.7	.9	1.4	18.0
Rye	76.6	1.8	2.6	11.6	6.8	.6	2.1	15.1
Sweet corn	79.1	1.3	1.9	4.4	12.8	.5	1.2	13.3
Tall oat grass	69.5	2.0	2.4	9.4	15.8	.9	1.1	14.6
Timothy	61.6	2.1	3.1	11.8	20.2	1.2	1.5	20.3
Green legumes:								
Alfalfa	72.9	2.6	4.7	8.0	11.0	.8	3.6	12.8
Alsike in bloom	74.8	2.0	3.9	7.4	11.0	.9	2.6	13.8
Cowpeas	82.5	2.5	3.4	4.0	7.1	.5	2.6	8.8
Crimson clover	80.9	1.7	3.1	5.2	8.4	.7	2.4	10.2
Red clover	70.8	2.1	4.4	8.1	13.5	1.1	2.9	16.4
Soy bean	75.1	2.6	4.0	6.7	10.6	1.0	3.1	12.2
Sweet clover	77.2	1.9	4.0	6.4	9.8	.7	3.1	11.1
Roots and tubers:								
Artichokes	78.0	1.8	2.4	.9	16.8	.1	1.5	16.1
Carrots	88.6	1.0	1.1	1.3	7.6	.4	.9	8.9
Mangels	91.2	1.0	1.4	.8	5.4	.2	1.1	6.4
Potatoes	78.9	1.0	2.1	.6	16.3	.1	1.3	16.3
Red beets	88.5	1.0	1.5	.9	8.0	.1	.9	8.7
Rutabagas	88.6	1.2	1.2	1.3	7.5	.2	1.0	8.5
Sugar beets	92.2	1.3	1.5	.7	4.3	-----	.9	4.8
Sweet potatoes	71.1	1.0	1.5	1.3	24.7	.4	.9	24.2
Turnips	90.6	.8	1.3	1.2	5.9	.2	1.2	7.4
Silage:								
Corn	70.9	1.4	2.4	6.9	17.5	.9	1.4	18.9
Corn stover	80.7	1.8	1.8	5.6	9.5	.6	1.0	11.8
Red clover	72.0	2.6	4.2	8.4	11.6	1.2	1.5	10.8
Sorghum	77.6	1.7	1.5	7.1	11.0	1.1	.9	14.8
Sweet clover	68.7	2.4	3.2	13.0	11.9	.8	1.1	12.6
Sunflower	77.9	2.1	1.8	6.5	10.1	1.6	1.1	11.9
Miscellaneous:								
Beet molasses	20.8	10.6	9.1	-----	59.5	-----	5.2	53.6
Cane molasses	24.0	6.8	3.1	-----	66.1	-----	1.8	59.5
Dried beet pulp	8.4	3.5	9.3	18.7	59.3	.8	4.9	66.9
Palmo midds [1]	6.3	5.2	16.2	7.7	56.7	7.9	13.1	64.5

[1] Wheat middlings used to absorb palm oil on tin plate in the manufacturing process.

Conversion factors for determining the comparative value of feeds

Feed	Converting factor	Protein difference in 1 ton of feed (compared with corn)	Feed	Converting factor	Protein difference in 1 ton of feed (compared with corn)
	Pc.	*Lbs.*		*Pc.*	*Lbs.*
Alfalfa hay	56	88	Kafir	70	−20
Alsike clover hay	54	48	Kentucky blue-grass hay	55	−48
Barley	85	66	Linseed meal, old process	62	472
Barley hay	64	−22	Malt sprouts	68	282
Barley straw	57	−128	Mangels	9	−120
Blood meal	3	1,176	Meadow-fescue hay	56	−84
Brewers' dried grains	60	294	Meat scraps	39	860
Buckwheat middlings	70	326	Oats	76	52
Cane molasses	80	−106	Oat hay	53	−64
Coconut meal, new process	67	244	Oat hulls	46	−108
Coconut meal, old process	87	242	Oat straw	54	−118
Corn	100	0	Orchard-grass hay	61	−44
Corn bran	87	−36	Peanut hulls	28	−72
Corncobs	71	−134	Peanut meal (high grade)	60	784
Corn fodder (field cured)	50	−92	Peanut straw	66	−18
Corn gluten feed	77	284	Potatoes	22	−116
Corn gluten meal	59	578	Red-clover hay	58	24
Corn (ground ear)	88	−56	Red-clover silage	14	−112
Corn husks (field cured)	38	−136	Red-dog flour	77	130
Corn silage	25	−114	Redtop hay	66	−46
Corn stover (field cured)	44	−114	Rice bran	81	46
Cottonseed	97	168	Rice polish	100	20
Cottonseed feed	60	398	Rutabagas	11	−122
Cottonseed hulls	48	−136	Rye	86	24
Cottonseed meal (cold pressed)	56	264	Rye straw	55	−130
Cottonseed meal (choice)	54	558	Screenings	72	52
Cottonseed meal (prime)	56	510	Sorghum hay	64	−72
Cottonseed meal (good)	56	476	Sorghum silage	19	−138
Cowpeas	78	248	Soy beans	81	570
Cowpea hay	49	96	Soy-bean hay	59	82
Crimson-clover hay	50	68	Soy-bean meal	63	716
Distillers' dried grains	93	146	Soy-bean straw	55	−86
Dried beet pulp	87	−44	Sudan-grass hay	59	−46
Elevator dust	53	0	Sugar beets	5	−124
Field peas	61	110	Sweet-clover hay	52	100
Hominy feed	103	0	Tankage	36	600
Johnson grass	63	−72	Timothy	60	−76
			Turnips	10	−118
			Vetch hay	58	90
			Wheat	85	54
			Wheat bran	65	108
			Wheat mixed feed	77	110
			Wheat middlings or shorts	80	122
			Wheat straw	50	−134

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Comparative Value of Feeds.—The principal use of the foregoing table is to determine the value of the principal feeds as compared with corn, when the prices of corn and any of the other feeds are known. Factors which have been termed "conversion factors" are worked out for this purpose. They are obtained by comparison to the total digestible carbohydrate equivalent of corn, which is found to be 74.8 pounds per 100 pounds of corn. Since all other feeds are to be compared with corn, a value of 100 is given it. The conversion factors or values of the other feeds are determined by division of their respective total carbohydrate equivalent by 74.8.

To obtain the "protein difference" the difference is found between the pounds of digestible protein in a ton of corn and in a ton of the feed considered. According to the feed-analyses table, a ton of shelled corn contains 142 (7.1×20) pounds of digestible protein.

As an example, compare the value of 1 ton of wheat bran and 1 ton of prime cottonseed meal. When 1 ton of shelled corn is worth \$27 (75.6 cents a bushel) 1 ton of wheat bran is worth \$17.55 (\$27 multiplied by 65 per cent, the converting factor) on the basis of the carbohydrate equivalent, and 1 ton of prime cottonseed meal is worth \$14.12 ($\$27 \times 46$). If the market price of bran is \$30 a ton the digestible protein in the bran costs 11½ cents a pound ($\$30 - \$17.55 = \$12.45$, which divided by 108, the excess of protein in bran over that in corn, equals 11½ cents). If the market price of prime cottonseed meal is \$38 a ton, the digestible protein in the cottonseed meal costs 4½ cents a pound ($\$38 - \$15.12 = \$22.88$, the cost of 510 pounds of digestible protein, and $\$22.88 \div 510 = 4\frac{1}{2}$ cents). Consequently it is evident, with the prices used above, that prime cottonseed meal is much cheaper as a source of protein than wheat bran.

Tonics and Condition Powders.—Healthy animals do not need tonics or condition powders. If a tonic is needed, the feeder should examine his methods. Plenty of good feed, fresh water, exercise, sunshine, pure air, and sanitary surroundings should keep an animal in good health. If a tonic is desired, one of known composition may be mixed at home. The following formulas are suggested for all stock except hogs:

FORMULA NO. 1

	Pounds
Glauber salt	2
Soda	1
Salt	1
Linseed meal	25
Fenugreek	⅛

FORMULA NO. 2

	Pounds
Glauber salt	5
Saltpeter	1½
Fenugreek	1
Gentian	2
Linseed meal	50

For horses a heaping tablespoonful of one of these mixtures fed with the grain three times a day is sufficient.

HORSES, MULES, ASSES, PONIES

There are estimated to be 130,000,000 horses, mules, and asses in the world, of which over 27,000,000, or more than 20 per cent, are in the United States, 18 per cent in Russia, and 8 per cent in Argentina. These three countries have over 45 per cent of the world total. Horses and mules are found in greatest numbers where agriculture is extensive, and asses are most common where population is dense and agriculture is intensive. The number of asses in China is equal to that of both horses and mules.

Horses

National Horse Associations.—The Horse Association of America, Wayne Dinsmore, secretary, Union Stockyards, Chicago, Ill., is a national organization to aid and encourage the breeding, rearing, and use of horses and mules. Other prominent associations devoted to this work are the National Association of Stallion Registration Boards, R. B. Cooley, secretary, La Fayette, Ind., and the National Society of Record Associations, R. P. Stericker, secretary, 72 West Adams Street, Chicago, Ill.

AMERICAN HORSE-RECORD ASSOCIATIONS

Arabian.—Arabian Horse Club of America. W. R. Brown, president, 1580 Woolworth Building, New York, N. Y.

Belgian.—American Association of Importers and Breeders of Belgian Draft Horses. J. D. Conner, jr., secretary, Wabash, Ind.

Cleveland Bay.—Cleveland Bay Society of America. R. P. Stericker, secretary, Room 1740, 72 West Adams Street, Chicago, Ill.

Clydesdale.—American Clydesdale Association. Miss M. Coridan, acting secretary, Union Stockyards, Chicago, Ill.

French Coach.—French Coach Horse Society of America. Duncan E. Willett, secretary, Maple Avenue and Harrison Street, Oak Park, Ill.

French Draft.—National French Draft Horse Association. C. E. Stubbs, secretary, Fairfield, Iowa.

German Coach.—German, Hanoverian, and Oldenburg Coach Horse Association of America. J. Crouch, secretary, La Fayette, Ind.

Hackney.—American Hackney Horse Society. Gurney C. Gue, secretary, Merrick, N. Y.

Morgan.—American Morgan Register. E. G. Stillman, president, 3 East Forty-fourth Street, New York, N. Y.

Percheron.—Percheron Society of America. Ellis McFarland, secretary, Union Stockyards, Chicago, Ill.

The American Breeders' and Importers' Percheron Registry Co. John A. Forney, secretary, Plainfield, Ohio.

Saddle.—American Saddle Horse Breeders' Association. R. H. Lillard, secretary, 434 West Main Street, Louisville, Ky.

Shetland.—American Shetland Pony Club. Miss Julia M. Wade, secretary, La Fayette, Ind.

Shire.—American Shire Horse Association. W. G. Lynch, secretary, Tonica, Ill.

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Standard Bred.—American Trotting Register Association. Frank E. Best, secretary, 137 South Ashland Boulevard, Chicago, Ill.
Suffolk.—American Suffolk Horse Association. R. P. Stericker, secretary, 72 West Adams Street, Chicago, Ill.
Thoroughbred.—The Jockey Club. Andrew Herkert, registrar, 66 West Fortieth Street, New York, N. Y.
Welsh Pony.—Welsh Pony and Cob Society of America. Miss Julia M. Wade, secretary, La Fayette, Ind.
Jack.—Standard Jack and Jennet Registry of America. William E. Morton, secretary, Scarritt Building, Kansas City, Mo.
American Breeders' Association of Jacks and Jennets. J. W. Jones, secretary, Columbia, Tenn.

EXHIBIT CLASSIFICATION FOR BREEDING CLASSES

Horses:
(1) Stallion 4 years old.
(2) Stallion 3 years old and under 4 years.
(3) Stallion 2 years old and under 3 years.
(4) Stallion 1 year old and under 2 years.
(5) Stallion foal.
(6) Champion stallion.
(7) Reserve champion stallion.
(8) Mare 4 years old.
(9) Mare 3 years old and under 4 years.
(10) Mare 2 years old and under 3 years.
(11) Mare 1 year old and under 2 years.
(12) Mare foal.
(13) Champion mare.
(14) Reserve champion mare.

Score card for the draft horse

Scale of points	Standard score
General appearance (18 points).	
Height: Estimated hands ——; actual hands ——.	
Weight: Estimated ——; actual ——; according to age and type	4
Form: Broad, deep, massive, well proportioned, low set	4
Quality and substance: Abundance of clean, flat bone; broad, well-defined joints and tendons; refined head and ears; fine skin and hair; feather, if present, silky	6
Temperament: Energetic, good disposition	4
Head and neck (7 points).	
Head: Proportionate, medium size, clean cut; wide lower jaw	1
Forehead: Broad, full	1
Eyes: Large, prominent, bright, clear	1
Muzzle: Broad, fine; large nostrils; trim, even lips	1
Ears: Of medium size, well set, carried alert	1
Neck: Medium long, muscular; good crest; clean throatlatch	2
Forehand (26 points).	
Shoulders: Sloping, muscular, blending into smooth withers	3
Arms: Short, muscular, elbow in	1
Forearms: Wide, muscular	2
Knees: Straight, wide, deep, well supported	2

Scale of point:	Standard score
Forehand—Continued.	
Cannons: Short, wide, lean, flat; large, well-defined tendons	2
Fetlocks: Wide, straight, tendons well back, well supported	1
Pasterns: Of medium length, oblique (about 45°), clean, strong	3
Feet: Large, round, set straight; dense, smooth horn; slope of wall parallel to pastern; wide heels; concave sole; strong bars; prominent, elastic frog	8
Leg position: In front, a perpendicular line from point of shoulder should divide the leg and foot into lateral halves; from the side, a similar line from the bony prominence on shoulder blade should pass through the center of elbow, knee, and pastern joints, and meet the ground back of foot	4
Body (9 points).	
Chest: Deep, wide, large girth	2
Ribs: Long, well sprung, close; strongly coupled	2
Back: Short, broad, heavily muscled	2
Loin: Short, wide, heavily muscled	2
Flanks: Deep, full; long, low underline	1
Hind quarters (30 points).	
Hips: Wide, smooth, level, well muscled	2
Croup: Long, wide, muscular, not markedly drooping	2
Tail: Set high, well carried	1
Quarters and thighs: Deep, thick, muscular, strongly joined to gaskins	3
Stifles: Muscular, well set	1
Gaskins (lower thighs): Wide, heavily muscled	2
Hocks: Wide, deep, prominent point, clean cut, straight, well supported	6
Cannons: Similar to front, except a trifle longer and wider	2
Fetlocks: Wide, straight, tendons well back, well supported	1
Pasterns: Similar to front, but less sloping (about 50°)	2
Feet: Similar to front, but not quite so large or so round	4
Leg position: From rear, a perpendicular line from point of buttock should divide the leg and foot into lateral halves; from the side, this same line should touch the point of hock and run parallel to the cannon. A similar line from the hip joint should meet the ground midway between the heel and toe	4
Action (10 points).	
Walk: Straight, long stride, springy and well balanced	6
Trot: Straight, long stride, free and regular	4
Total	100

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Score card for the light-harness horse

Scale of points	Standard score
General appearance (12 points).	
Height: Estimated hands ——; actual hands ——.	
Weight: Estimated ——; Actual ——.	
Form: Long, deep, angular, yet symmetrical, smooth, stylish	4
Quality: Clean, dense bone with sufficient substance; well-defined joints and tendons; fine skin and hair	4
Temperament: Active; good disposition	4
Head and neck (7 points).	
Head: Proportionate, clean cut, straight; wide lower jaw	1
Forehead: Broad, full	1
Eyes: Large, prominent, bright, clear	1
Muzzle: Fine, large nostrils, thin and even lips	1
Ears: Of medium size, fine, pointed; set close, carried alert	1
Neck: Long, lean, slightly arched; clean-cut throatlatch	2
Forehand (25 points).	
Shoulders and withers: Long, smooth, sloping shoulders, blending into smooth, well-defined withers extending well back	4
Arms: Short, muscular, carried well forward	1
Forearms: Long, wide, muscular	2
Knees: Straight, wide, deep, clean, well supported	2
Cannons: Short, wide, lean, flat; prominent, defined tendons	2
Fetlocks: Wide, straight, tendons well back, well supported	1
Pasterns: Long, oblique (about 45°), clean, strong	3
Feet: Of medium size, round, even, set straight; dense, smooth horn; slope of wall parallel to pastern; wide, high heels; concave sole; strong bars; prominent elastic frog	6
Leg position: In front, a perpendicular line from point of shoulder should divide the leg and foot into lateral halves; from the side, a similar line dropped from the bony prominence on shoulder blade should pass through the center of elbow, knee, and pastern joints, and meet the ground back of foot	4
Body (9 points).	
Chest: Deep, of medium width, large girth	2
Ribs: Long, sprung, close	2
Back: Short, broad, strong	2
Loin: Short, wide, strong	2
Flanks: Deep, full; long, low underline	1
Hind quarters (30 points).	
Hips: Wide, smooth, level	2
Croup: Long, wide, muscular, fairly level	2
Tail: Set high, well carried	1
Quarters and thighs: Deep and muscular quarters; long, muscular thighs, strongly joined to gaskins	3
Stifles: Well set, strong, muscular	1
Gaskins (lower thighs): Long, wide, muscular	2
Hocks: Straight, wide, prominent points, deep, flat, clean cut, well supported	6
Cannons: Similar to front cannons, except a trifle longer	2
Fetlocks: Wide, straight, tendons well back, well supported	1
Pasterns: Similar to front, but not so sloping (about 50°)	2
Feet: Similar to front, but not quite so large nor so round	4

Score card for the light-harness horse—Continued

Scale of points	Standard score
Hind quarters—Continued.	
Leg position: From rear, a perpendicular line from point of buttock should divide the leg and foot into lateral halves; from the side, this same line should touch the point of hock and run parallel to the cannon. A similar line from the hip joint should meet the ground midway between the heel and toe	4
Action (17 points).	
Walk: Elastic, quick, long, free stride	5
Trot: Straight, long, free stride, with shoulder action; rapid, regular	12
Total	100

Mules

Mules in the United States.—The number of mules on farms in the United States on January 1, 1920, was 5,432,391. The number estimated on January 1, 1925, was 5,411,000. Of this number 3,490,000, or about 64 per cent, are in 10 Cotton Belt States, which rank as follows:

Texas	854,000	Alabama	314,000
Georgia	375,000	Mississippi	308,000
Oklahoma	330,000	North Carolina	260,000
Arkansas	328,000	South Carolina	215,000
Tennessee	326,000	Louisiana	180,000

The only Cotton Belt States that have more horses than mules are Texas and Oklahoma.

Score card for the mule

Scale of points	Standard score
General appearance (16 points).	
Height: Estimated hands ——; actual hands ——.	
Weight: Estimated ——; actual ——; according to age and type	4
Form: Broad, deep, compact, smooth, symmetrical	4
Quality: Clean, dense bone with sufficient substance; refined head and ears; fine hair; defined joints and tendons	4
Temperament: Active; good disposition	4
Head and neck (7 points).	
Head: Proportionate; clear-cut features	1
Forehead: Broad, full	1
Eyes: Full, bright, clear	1
Muzzle: Broad, fine; large nostrils; trim and even lips	1
Ears: Large, long, pointed, fine, well set, carried alert	1
Neck: Long, muscular, clean-cut throatlatch	2

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Score card for the mule—Continued

Scale of points	Standard score
Forehand (24 points).	
Shoulders: Long, sloping, smooth, muscular, blending into smooth, well-defined withers	3
Arms: Short, muscular, elbows in	1
Forearms: Long, wide, muscular	2
Knees: Straight, wide, deep, well-supported	2
Cannons: Short, wide, flat, well-defined tendons	2
Fetlocks: Wide, straight, tendons well back, well supported	1
Pasterns: Medium length, oblique (about 45°), clean, strong	3
Feet: Of medium size, set straight; dense, smooth horn; slope of wall parallel to pastern; wide, high heels; concave sole; strong bars; prominent, elastic frog	6
Leg position: In front, a perpendicular line from point of shoulder should divide the leg and foot into lateral halves from the side, a similar line from the bony prominence on shoulder blade should pass through the center of elbow, knee, and pastern joints, and meet the ground back of foot	4
Body (9 points).	
Chest: Deep, wide	2
Ribs: Long, well sprung, close	2
Back: Short, broad, strong	2
Loin: Short, wide, muscular	2
Flanks: Deep, full; long, low underline	1
Hindquarters (32 points).	
Hips: Wide, level, smooth, muscular	2
Croup: Long, level, muscular	2
Tail: Set high, well carried	1
Quarters and thighs: Deep and muscular; strongly joined to gaskin	3
Stifles: Broad, thick, strong	1
Gaskins (lower thighs): Long, wide, muscular	2
Hocks: Straight, wide, prominent points, deep, flat, clean cut, well supported	6
Cannons: Similar to front, but a trifle longer and wider	2
Fetlocks: Wide, straight, tendons well back	2
Pasterns: Similar to front, but less sloping (about 55°)	3
Feet: Similar to front, but not quite so large	4
Leg position: From rear, a perpendicular line from point of buttock should divide the leg and foot into lateral halves; from the side, this same line should touch the point of hock and run parallel to the cannon. A similar line from hip joint should meet the ground midway between heel and toe	4
Action (12 points).	
Walk: Active, straight, balanced, long stride	7
Trot: Straight, long, free, regular, snappy stride	5
Total	100

Feeding (Horses)

No one feed or combination of feeds will meet conditions in all parts of the country. Generally speaking, combinations of home-grown or locally raised crops constitute the most economical rations. The kind of feed used, the quantity required per animal, and the manner of feeding depend on the age, size, and condition of the horse, the amount and kind of work done, and the individual fed.

Feeds—*Concentrates.*—Chief among the concentrates used in horse feeding are oats, corn, bran, and barley.

Dry roughage.—Timothy, alfalfa, clover, and prairie hay and corn stover are the principal dry roughages fed to horses.

Pasture.—Pasture ranks foremost among the succulent feeds for horses. It is invaluable in the maintenance of idle horses and acts as a laxative, tonic, and appetizer, and furnishes exercise for work stock.

Mineral Requirements.—Horses should receive their mineral matter in the form of feeds. Legumes are especially valuable sources of mineral matter, and as such are excellent for young stock and breeding animals. It is a good plan to furnish salt at frequent, regular intervals, or to have it accessible at all times. An average of three-fourths ounce daily per head will be required under normal conditions.

Rations.—Composition of the horse ration is dependent upon the individual fed, the kind and amount of work done, and the feeds available. Individual feeding gives the best results. Horses of the same type and weight may have different feed requirements, which make it necessary to study the individuality of the animals fed. Necessary changes in rations should be made gradually to prevent digestive disturbances.

SUGGESTED DAILY RATIONS FOR HORSES

Rations for 1,000-pound idle horse

	Pounds		Pounds
Ration No. 1:		Ration No. 2:	
Ear corn	5	Cowpea hay	5
Alfalfa hay	3	Corn silage	5
Corn stover	9	Timothy hay	10

Rations for 1,000-pound horse at very light work

	Pounds		Pounds
Ration No. 3:		Ration No. 4:	
Oats	8	Cowpeas (cracked)	5
Alfalfa hay	4	Molasses	5
Timothy hay	6	Oat straw	10

Rations for 1,000-pound horse at medium work

	Pounds		Pounds
Ration No. 5:		Ration No. 6:	
Ear corn	13	Shelled corn	11
Alfalfa hay	6	Cowpea hay	6
Timothy hay	7	Corn stover	6

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Rations for 1,000-pound horse at hard work

	Pounds		Pounds
Ration No. 7:		Ration No. 8:	
Oats	12	Rolled barley	10
Bran	2	Gluten meal	2
Timothy hay	8	Alfalfa hay	8
Clover hay	5	Prairie hay	6

Breeding stock.—Rations for breeding stock must supply sufficient protein and mineral matter to keep the animals in an active, thrifty, vigorous condition without laying on excessive flesh. Legumes, oats, bran, oil meal, and feeds of like character are generally used in the breeding-stock ration.

Growing stock.—Young stock should be taught to eat grain at an early age, and after weaning kept in a thrifty, growing condition by being fed a ration rich in protein and mineral matter. Crushed oats, bran, and similar concentrates, combined with legume hay and nutritious pasture, will make an excellent ration for young growing stock. Especially liberal feeding is recommended for the first year, as the colt makes half of its growth during this period.

Work stock.—Rations for the work horse should be composed largely of energy-producing feeds, such as corn, oats, timothy, and legume hay. Horses at moderate work require approximately $1\frac{1}{10}$ pounds grain and $1\frac{1}{5}$ pounds of hay per 100 pounds live weight; horses at heavy work require $1\frac{1}{4}$ to $1\frac{1}{3}$ pounds of grain and $1\frac{1}{4}$ pounds of hay per 100 pounds live weight.

Water.—The consensus of opinion on watering horses is that water may be given before, during, or after feeding without injurious effects, provided the system adopted is followed regularly. The average daily requirement per horse approximates 10 to 12 gallons. Weather conditions, the nature of the work done, and the kind of feed consumed are factors determining the quantity of water that will be needed.

Management

Care.—Management of horses varies with the seasons and with the class of stock kept, and the objective of all horsemen should be to keep animals in shape for the work on hand. Careful feeding, proper exercise and grooming, correct stabling, and judicious handling are all essential.

Estimation of age by teeth (horses).—The age of horses may be rather accurately estimated by an examination of the teeth. The time of eruption, the "cups" or depressions on the wearing surfaces, and the form and direction of the teeth are all indicative of age at different periods of life. The following table gives data from which age can be determined rather definitely:

Determination of age in horses

Location of teeth	Age at eruption		"Cups" disappear from wearing surfaces of permanent teeth of—	
	Temporary or colt teeth	Permanent or horse teeth	Lower jaw at—	Upper jaw at—
First pair of middle incisors or "nippers."	Birth to 4 weeks.	2½ to 3 years.	5½ to 6 years.	9 to 10 years.
Second pair of incisors (located at either side of the "nippers").	4 to 8 weeks.	3½ to 4 years.	6½ to 7 years.	10 to 11 years.
Third pair or corner incisors.	7 to 10 months.	4½ to 5 years.	7½ to 8 years.	11 to 12 years.

In older horses it becomes more difficult to estimate the age; however, the shape of the wearing surface gradually changes from triangular to rounded, and the direction of the teeth becomes more slanting.

Brood mare.—Pregnant mares may be kept in condition if worked regularly or exercised. Feed should be ample for work, body maintenance, and development of the fetus. As foaling time approaches lighten the work and make the ration laxative in character. Light work may generally be resumed two weeks after parturition.

Foal.—Immediately after birth see that the foal suckles, and disinfect the navel cord. Foals running with their dams on pasture may be taught to eat at an early age by the placing of a small quantity of grain (crushed oats or oatmeal with bran) in a creep. Young foals with working dams should be confined in a cool, dark stall and allowed to suckle several times daily. They may be weaned at the age of 4 to 6 months. Breaking and training should be begun at an early age and followed systematically until the working period is reached.

Sire.—Regulation of services, work or exercise, good feed, roomy, sanitary quarters, and regular grooming are the essentials of stallion management. During breeding season the feed should be chiefly protein in character and ample to keep the sire in good flesh. Preferably one and not more than two services a day should be allowed.

Work stock.—Regularity in working, feeding, and grooming gives best results in the care of work stock. Care should be taken in devising hitches and in fitting the harness.

Miscellaneous.—Horses will render more efficient service over a greater length of time if regular care is given to their teeth, feet, and legs, the fitting of harness, and grooming. The horse should always stand plumb and square, and where work is done on hard surfaces shoes are a necessity. The feet of young stock and unshod idle horses should be leveled regularly with a rasp. At least once a year have a competent veterinarian examine the teeth of all horses. "Floating" is generally all that will be required to put the teeth in good shape.

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Equipment—*Shelter.*—Expensive, pretentious stables are not essential to successful management, provided the equipment used is accessible and furnishes warm, dry, sanitary shelter when necessary. Sheds protected from high winds and dampness, and which are readily accessible for feeding, are valuable for the housing of idle horses and young stock in inclement weather. Roomy box stalls are necessary where pregnant mares or mares and foals are kept in the stable. Litter carriers and accessibility to feed, water, and harness will assist greatly in expediting the work of management.

Harness and hitches.—Each work horse should have its own set of harness, which when not in use may be hung on pegs behind the stall or placed in a harness room. It is a good plan to give each set a thorough overhauling, cleaning, and oiling at least twice a year in addition to the daily cleaning of all bearing surfaces.

The use of multiple hitches is recommended for field work wherever practicable. Directions for making multiple hitches may be procured from Animal Husbandry Division, Bureau of Animal Industry, United States Department of Agriculture, Washington, D. C.

Lots and fences.—Exercise lots for stallions, idle horses, and young stock are necessary. Large breeding establishments frequently have such lots connected directly with the stable, with provisions for access to the runs made directly from the box stalls. The most satisfactory material, aside from its cost, for fencing these and other inclosures in which horses are to be kept is the post and rail or board fence. A good grade of closely woven wire is likewise satisfactory, but barbed wire should never be used.

Sanitation.—All stables and shelters used for horses should be dry, well drained, clean, light, and well ventilated. Clay floors that are kept smooth are best, but a concrete base covered with boards, cork brick, or wood block makes satisfactory flooring. Liberal use of bedding aids in keeping the stall dry and sanitary. Idle horses and work stock at night should, if possible, have access to pasture.

Marketing

General.—Market demands usually are greatest for high-class drafters, heavy wagon horses, and saddle-horse types. East St. Louis and Chicago are the principal markets.

Breeding stock.—The major portion of breeding stock is disposed of by private treaty. Other animals are auctioned off at community, fair, farm, and exposition sales. Wherever possible the breeder should produce stock of the breed prevalent in his locality, as this facilitates breeding operations and offers an outlet for marketable animals.

Work stock.—The favored plan for selling work stock is to raise a crop of foals each year, work the horses raised until about 7 years old, then place them on the market. Where mares of the same type are kept and served by the same stallion, additional profit may frequently be made by the production and sale of matched teams.

Young stock.—Disposal of young stock, unless it be surplus or purebred, is not to be recommended, as this practice leaves no replacement material on the farm. Young work stock, moreover, ordinarily can not be sold for the profit realized from older animals.

Use and Production of Ranch Work Animals

Saddle and Work Horses Used in Handling Cattle.—At the present time the number of saddle horses used by cattlemen varies from five to eight per man. The small rancher who lives in the dry-farming or irrigated sections, averaging about 50 head of cattle, usually keeps three to four saddle horses. The rancher who has 200 to 400 head of cattle usually employs two men besides himself and has four or five horses per man. On the large ranches, with two men to every 1,000 head of cows, occasionally a string of 10 to 16 horses is found. A survey in the State of Colorado showed that there were three saddle horses per man for all cattle work.

Mules are not numerous in the range country. Ordinarily they do not have the right disposition or the proper gait to be used for saddle purposes. Mules and burros, however, have been profitably used, especially for pack and saddle purposes in rough country where surefootedness is essential.

Type of saddle horse.—The type of saddle horse most desired in handling cattle stands about 15 hands 2 inches in height, weighs about 1,050 to 1,100 pounds, has good feet and legs, a good flat-footed walk, square trot, and an easy lope. The horse must be sure-footed, active, and possess stamina and easy-keeping qualities. Fewer saddle horses are required when good animals are used. The man who is riding the average "cow horse" of the present day in the round-up has to change more often than the man who is riding a well-bred horse.

Type of work horse.—Small ranches have at least six work horses. The number will naturally depend on the acreage being farmed. In general the type desired is a farm chunk, although many men like a big horse of light-blood breeding—a utility horse that may be used for saddle as well as for work. This horse may be described as 15–2 to 16 hands, weighing 1,250 to 1,300 pounds, with good conformation and plenty of action.

Feeding and care.—During hard work, horses are generally fed at least a light feed of grain and grazed when not under the saddle. Feeding and care affect the number of saddle horses required per man. Years ago, a string of 10 to 12 horses per man was considered essential during the round-up. Men now use but 3 to 5 horses and often only 2.

Work Animals Used in Handling Sheep.—One or possibly two saddle horses and a pair of work horses for the sheep tender's wagon are required per band of sheep. In addition, the average sheepman will have a string of 6 horses for hauling wool and feed per band, making an average of 4 or 5 horses per 1,000 sheep. Horses have proved most desirable for this purpose. Burros and mules are used to some extent, particularly in the Southwest.

Breeding Ranch Horses.—Most of the larger ranchmen find it advisable to produce both saddle and work horses. On smaller ranches, when a good stallion is available, at least enough horses should be produced to provide for replacement purposes. Selection of the best type of mares now found on the ranches is recommended. Although the best mares may be getting old, they should be used in preference to the younger misfits. Judicious selection of the sires, of Thoroughbred, Morgan, or utility breeding, will improve the saddle stock. For the production of work horses a well-made, medium-sized draft sire is necessary. Fewer but better-bred colts are needed. Promiscuous range breeding has produced a type of range horse that is not altogether desirable. "Catch" colts

have been mutiplying and decreasing the value of the range horses with each generation. The rancher must of his own initiative castrate his yearlings and use his influence in getting his neighbors to do likewise. He also must use a severe selective process on his brood mares and be careful to mate only to sound stallions of the right type.

Feeding the Breeding and Young Animals.—Correct feeding is essential for a general increase in the size of the animal. Most weanlings are fed hay only, which does not tend toward the proper development of the young animal. The use of small or medium-sized Thoroughbred sires on the small native mare has produced only a very small type of range saddle horse. Grain is profitably fed to well-bred growing stock and will help to increase the size and better the condition of the western horse. Provide shelter and hay for breeding animals, at least during storms. Such care will help to carry the mares through the winter in fair condition for foaling and will give the foal a better start. Handling the weanlings and breaking and training the 4-year-olds with some light work and feed will help to put the spirit in saddle and work horses.

The demand for good saddle horses is increasing in the range country. A number of breeders have received very good prices for well-broken polo ponies and for saddle horses for use in cities and in summer tourist camps. In addition there is a demand for a better "cow horse."

BEEF AND DUAL-PURPOSE CATTLE

General

AMERICAN RECORD ASSOCIATIONS

Aberdeen Angus.—American Aberdeen-Angus Breeders' Association. W. H. Tomhave, secretary, 817 Exchange Avenue, Chicago, Ill.

Devon.—American Devon Cattle Club. Richard Pattee, secretary, 51 Cornhill Street, Boston, Mass.

Galloway.—American Galloway Breeders' Association. R. W. Brown, secretary, Carrollton, Mo.

Hereford.—American Hereford Cattle Breeders' Association. R. J. Kinzer, secretary, 1012 Baltimore Avenue, Kansas City, Mo.

Polled Shorthorn.—American Polled Shorthorn Breeders' Society. J. H. Martz, secretary, Hannibal, Wis.

Polled Hereford.—American Polled Hereford Breeders' Association. B. O. Gammon, secretary, Des Moines, Iowa.

Red Polled.—Red Polled Cattle Club of America. H. A. Martin, secretary, Gotham, Wis.

Shorthorn.—American Shorthorn Breeders' Association.[1] P. K. Groves, secretary, 13 Dexter Park Avenue, Chicago, Ill.

Exhibit Classification for Beef Cattle.—Committees appointed by the American Hereford Cattle Breeders' Association, the American Aberdeen-Angus Breeders' Association and the American Shorthorn Breeders' Association adopted and submitted to the National Association of Fair Managers a new classification for fairs and shows in 1925.

Breeding cattle:

Class 1.—Bulls calved before June 1, 1922.

Class 2.—Bulls calved between June 1, 1922, and May 31, 1923.

Class 3.—Bulls calved between June 1 and December 31, 1923.

Class 4.—Bulls calved between January 1 and May 31, 1924.

Class 5.—Bulls calved between June 1 and September 30, 1924.

Class 6.—Bulls calved after October 1, 1924.

Class 7.—Three bulls owned by exhibitor.

Class 8.—Two bulls bred and owned by exhibitor. (Classes 3, 4, 5, and 6.)

Class 9.—Senior champion. (Classes 1, 2, and 3.)

Class 10.—Junior champion. (Classes 4, 5, and 6.)

Class 11.—Grand champion. (Classes 9 and 10.)

Class 12.—Cows calved before June 1, 1922.

Class 13.—Cows calved between June 1, 1922, and May 31, 1923.

Class 14.—Heifers calved between June 1 and December 31, 1923.

Class 15.—Heifers calved between January 1 and May 31, 1924.

Class 16.—Heifers calved between June 1 and September 30, 1924.

Class 17.—Heifers calved after October 1, 1924.

Class 18.—Hereford: Two females, any age, bred and owned by exhibitor. Aberdeen-Angus: Two females, any age, bred and owned by exhibitor. Shorthorn: Cow calved before June 1, 1922, with own calf at side, calved after October 1, 1924.

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[1] The Milking Shorthorn Society and the Polled Shorthorn Breeders' Association have amalgamated with the American Shorthorn Breeders' Association.

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Breeding cattle—Continued.

Class 19.—Senior champion female. (Classes 12, 13, and 14.) (Shorthorns, 18.)

Class 20.—Junior champion female. (Classes 15, 16, and 17.)

Class 21.—Grand champion female. (Classes 19 and 20.)

Class 22.—Aged herd: One bull from classes 1, 2, and 3; one cow from class 12 (or 18, Shorthorn); one heifer from class 13 or 14; one heifer from class 15 or 16; and one heifer from class 17.

Class 23.—Yearling herd: One bull from class 4 or 5 and two heifers from class 15 or 16; heifers to be bred by exhibitor.

Class 24.—Pair of calves: Bull from class 6 and heifer from class 17, both to be bred by exhibitor.

Class 25.—Four animals the get of one sire, both sexes to be represented, any age, all to be owned by exhibitor.

Fat steers (purebred or grade):[1]

Class 26.—Steers calved between September 1, 1923, and December 31, 1923.

Class 27.—Steers calved between January 1, 1924, and August 31, 1924.

Class 28.—Steers calved after September 1, 1924.

Class 29.—Champion steer.

Class 30.—Group of three steers, any age, from classes 26, 27, and 28.

Score card for fat and feeder beef cattle

Scale of points	Standard score
General appearance (38 points).	
Weight (according to age): Estimated pounds ------; actual pounds	10
Form: Broad, deep, low set, smooth, compact, cylindrical; straight top and underline; stylish	10
Quality: Loose, pliable skin of medium thickness; dense, clean, medium-sized bone; fine, soft hair	8
Condition: Deep, even covering of firm, mellow flesh, free from patches, ties, lumps, and rolls; full cod and flank indicating finish	10
Head and neck (6 points).	
Muzzle: Broad; mouth large; nostrils large and open	1
Eyes: Large, clear, placid	1
Face: Short, jaws strong	1
Forehead: Broad, full; ears medium sized, fine texture	1
Neck: Short, thick, blending smoothly with shoulders; throat clean, with light dewlap	2
Fore quarters (8 points).	
Shoulder vein: Full	2
Shoulders: Smoothly covered, compact, snug, and neat	3
Brisket: Trim, neat; breast, wide and full	2
Legs: Wide apart, straight, short, arm full; shank fine	1

[1] For fairs and shows in 1926 the base dates for steers will be the same as for breeding classes. For all shows held after November 1 separate classes will be provided for bull, heifer, and steer calves dropped after January. These calves will be eligible to show in group classes 22, 24, and 25.

Score card for fat and feeder beef cattle—Continued

Scale of points	Standard score
Body (30 points).	
Chest: Full, deep, wide; girth large; crops full	4
Ribs: Long, arched, thickly and smoothly fleshed	8
Back: Broad, straight, thickly and smoothly fleshed	8
Loin: Thick, broad, evenly covered	8
Flank: Full, even, with underline	2
Hindquarters (18 points).	
Hips: Smooth, evenly covered	2
Rump: Long wide, level; tail head, smooth; pin bones wide apart, not prominent	5
Thighs: Deep, full	5
Twist: Deep, plump	5
Legs: Wide apart, straight, short; shanks, fine, smooth	1
Total	100

Score card for breeding beef cattle

Scale of points	Standard score
Weight and size (according to age)	10
Form: Deep, broad throughout, low set; straight top and underline	25
Constitution: Good depth and width of chest	15
Quality: Smooth throughout; good handler, as indicated by soft, loose, pliable skin covered with fine, mossy hair; bone fine, yet of sufficient substance and strength to carry body	15
Condition: Carrying enough natural flesh to indicate vigor; free from patchiness	10
Breed, type, and color: Clean-cut head and neck with good form; color markings typical for breed	10
Sex character: Strong, masculine head and neck in bull; more refinement throughout in cow than in bull	10
Disposition: Docile, with quiet temperament	5
Total	100

Breeding

For the junior classification females should be bred between March 26 and April 16 in order to have the calves drop as soon after January 1 as possible.

For the senior classification breed between November 24 and December 15 to have the calves come shortly after September 1.

In baby-beef production, where spring calves are desired, breed cows in June or July, and where fall calves are desired, in December and January.

Feeding

Getting Steers on Full Feed.—Starting steers on feed requires careful management. Gradual increases in the quantities of feed in the ration, as determined by careful observation, are essential to success in getting steers up to full eating capacity. The time required depends primarily upon the length of feeding period and is influenced by the age of the cattle. The feeding period for 2-year-olds varies from 5 to 7 months, with an average in the Corn Belt of about 175 days. Older cattle fatten

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in a shorter period; younger cattle require a longer period. As an illustration, when 2-year-old cattle are to be fed a corn and clover ration for a 6-month period a good practice is to increase the quantities of feed gradually so that the cattle will be on full feed in not less than 30 days. They can be handled safely as follows: Start with 2 pounds of corn the first day and increase 1 pound a day until 10 pounds is reached. Hold at this point for 4 days. Then increase 1 pound every 3 days until 20 pounds is reached, which will be in about 40 days. The steers can receive all the roughage they are able to consume from the beginning without any ill effects.

When protein concentrates are used in the fattening ration increases should be even more gradual than with corn. A conservative quantity of cottonseed or linseed meal to start cattle on would be half a pound per head.

In a general way all concentrates should be gradually increased as the feeding period advances, and roughages should be decreased.

Feeder cattle from the range areas are usually not accustomed to eating grain. In fact, very few ever have eaten feeds other than grass and hay. Under these conditions cattle usually can be taught to eat corn more readily if fed corn fodder on grass pasture than if induced to eat out of a feed bunk at the start.

Comparative protein costs: Cost of 1 pound of crude protein in feeds most commonly used as a source of protein in cattle feeding

Price of feed per ton	Cost per pound of crude protein[1]				
	Clover hay	Alfalfa hay	Wheat bran	Linseed meal	Prime cotton-seed meal[2]
	Cents	*Cents*	*Cents*	*Cents*	*Cents*
$5	1.79	1.56			
$7.50	2.68	2.34			
$10	3.57	3.12			
$12.50	4.47	3.90			
$15	5.36	4.69	4.69		
$17.50	6.25	5.46	5.46		
$20	7.14	6.25	6.25	2.86	2.56
$22.50	8.04	7.02	7.02	3.21	2.88
$25	8.93	7.81	7.81	3.57	3.20
$27.50	9.83	8.59	8.59	3.92	3.52
$30	10.71	9.37	9.37	4.28	3.85
$35	12.50	10.94	10.94	5.00	4.49
$40	14.29	12.50	12.50	5.71	5.13
$45		14.06	14.06	6.43	5.77
$50		15.62	15.62	7.14	6.41
$55			17.19	7.86	7.05
$60			18.75	8.57	7.69
$65				9.28	8.33
$70				10.00	9.97

[1] The feeds contain crude protein approximately as follows: Clover hay, 14 per cent; alfalfa hay and wheat bran, 16 per cent; linseed meal, 35 per cent; and prime cottonseed meal, 39 per cent.

[2] Cottonseed meal is sold in three grades: Choice, containing at least 41 per cent protein; prime, with at least 38.6 per cent protein; and good, containing at least 36 per cent protein. Meal falling below 36 per cent protein is classed as cottonseed feed. The prime grade is used most extensively.

Digestible Nutrients Required for Pound of Gain.—9 to 11 pounds for 2 and 3 year olds; 6 to 8 pounds for yearlings; 4 to 8 pounds for calves.

Feeds.—The amount of beef that can be produced from 100 pounds of corn fed to a steer of good quality will depend largely upon the kind and quantities of other feed fed in connection with corn.

A 2-year-old steer, 800 pounds in weight, fed a hay and corn ration should produce 6 pounds of beef per bushel (56 pounds) or 10½ pounds of beef per 100 pounds corn.

Number of animals that can be fed from silos of various sizes

[Basis of 40 pounds of silage per cubic foot]

WINTER FEEDING TO A DEPTH OF 2 INCHES DAILY

Inside (feet) diameter of silo	Number of animals that may be fed, allowing—			
	40 pounds per head	30 pounds per head	20 pounds per head	15 pounds per head
	Animals	*Animals*	*Animals*	*Animals*
10	13	17	26	35
11	16	21	31	42
12	19	25	37	50
13	22	29	44	59
14	25	34	51	68
15	29	39	59	78
16	33	44	67	89
17	38	50	75	101
18	42	56	85	113
20	52	70	104	139

SUMMER FEEDING TO A DEPTH OF 3 INCHES DAILY

10	19	26	39	52
11	23	31	47	63
12	28	37	56	75
13	33	44	66	88
14	38	51	77	102
15	44	59	88	118
16	50	67	100	134

Mineral Requirements.—Beef cattle seldom need a mineral supplement in addition to salt, particularly if they are provided with a variety of feeds. However, if there is a deficiency of minerals in feeds, the result of a deficiency in minerals in the soils producing them, the following supplements are suggested:

(1) Three parts common salt and one part bone meal (steamed preferred).

(2) Two parts salt and one part wood ashes, ground limestone, or bone ash.

Salt should be accessible at all times. Beef cattle require from three-fourths to 1 ounce per day per 1,000 pounds live weight.

Rations.—These rations are in each case based upon the requirements per 1,000 pounds of live weight. A 500 or 200 pound animal, therefore, would require only one-half or one-fifth of the total quantities of feed suggested in each case.

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Rations for beef cattle per 1,000 pounds of live weight

Class	Desired nutritive ratio	Rations[1] With silage		Rations[1] Without silage	
Herd bulls	1:9	Corn silage	15	Corn stover	7
		Clover hay	8	Clover hay	8
		Corn stover	2	Corn	2
		Oats	2	Oats	2
		Corn	2		
Dry cows carrying calf.	1:10	Corn silage	45	Corn stover	10
		Clover hay	6	Clover hay	7
		Corn	2	Corn	2
Cows suckling calves.	1:9	Corn silage	40	Corn stover	8
		Clover hay	8	Clover hay	8
		Corn	4	Corn	[illegible]
		Cottonseed meal.	0.2	Cottonseed meal.	0.25
Growing calves;[2] weight, 100 to 250 pounds.	1:5	----------		Clover hay	3
				Corn	2
				Oats	4
				Linseed meal	1
Growing calves;[2] weight, 250 to 400 pounds.	1:5.7	----------		Clover hay	5
				Corn	5
				Oats	5
				Linseed meal	1
Growing calves;[2] weight, 400 to 700 pounds	1:6	Corn silage	15	Clover hay	13
		Clover hay	8	Corn	3
		Corn	8	Oats	5
		Linseed meal	1.2		
Growing yearlings;[2] weight, 700 to 1,200 pounds.	1:6.5	Corn silage	25	Oat straw	2
		Clover hay	8	Corn	7
		Corn	5	Alfalfa	14
		Cottonseed meal.	2.3		
Young fattening cattle; weight, 400 to 800 pounds.	1:6.4	Corn silage	15	Clover hay	9
		Clover hay	4	Corn	15
		Corn	8	Linseed meal	2.5
		Oats	4		
		Cottonseed meal.	2		
Young fattening cattle; weight, 800 to 1,000 pounds.	1:7	Corn silage	20	Clover hay	10
		Corn stover	4	Corn	18
		Corn	12	Linseed meal	2
		Cottonseed meal.	3.5		
Wintering stockers.	1:10	Corn silage	35	Clover hay	10
		Wheat straw	8	Oat straw	15
		Cottonseed meal.	1.5		
Fattening 2-year-old steers.	1:7.6	Corn silage	30	Alfalfa hay	10
		Clover hay	5	Corn	20
		Corn	15		
		Cottonseed meal.	2		

[1] Barley may be substituted for corn, pound for pound. Grain sorghums may be substituted for corn, 10 pounds for 9 pounds. Root crops may be substituted for corn silage, 9 pounds for 8 pounds.
[2] Intended primarily for breeding purposes.

Feed required to keep a beef cow for one year in the Corn Belt

[Average of 354 farms]

Winter feeding (5½ months):		
Grain	pounds	122
Hay	do	1,900
Silage	do	700
Straw	do	660
Corn fodder	acres	.12
Cornstalks	do	1.60
Corn stover	do	.24
Winter pasture	days	4
Summer feeding (6½ months):		
Pasture		

Water.—For beef and dual-purpose cattle 1 to 1½ gallons of water per day should be allowed per 100 pounds of live weight. The quantity required will vary greatly, depending upon the kind of feed given. Green feeds, silages, and roots reduce the quantity of water required, and legumes, hays, and other feeds rich in protein increase the quantity required.

Management

Estimation of Age (Cattle).—From a practical standpoint the age of cattle is usually determined by the horns, the length of the tail, and the general appearance of the animal; however, the time of eruption of the teeth is a rather accurate guide.

There are four pairs of temporary incisors in the lower jaw that usually appear during the first few weeks of life. They are replaced by an equal number of permanent incisors that erupt about as follows:

TEETH	AGE AT ERUPTION
First or middle pair incisors	15 to 18 months
Second pair incisors	24 to 30 months
Third pair incisors	33 to 36 months
Fourth pair incisors	42 to 48 months

LENGTH OF FATTENING PERIODS

Mature feeders	3 to 4 months
Two-year-olds	5 to 7 months
Yearlings	8 to 10 months
Calves	10 to 12 months

Identification.—Many earmarking systems for identifying animals are used, but the following suggested plan is simple and easy to remember:

Earmarks for identification of animals

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Explanation.—A notch in the outer margin of the right ear always has a value of 1, no matter where it is located in the margin. Similarly, a notch in the outer margin of the left ear always has a value of 3; one in the inner margin of the right ear always has a value of 10, and one in the inner margin of the left ear 30. Simply insert notches sufficient to make the desired number, beginning with the largest possible unit. Each ear margin furnishes space enough for three or more notches, so that animals in relatively large herds may be given individual numbers.

Farm Beef Supply

Percentages of wholesale beef cuts to carcass weights[1]

Cuts	Source of data			
	Ill. Exp. Sta. Bul. 158	Iowa Exp. Sta. Cir. 72	Nebr. Exp. Sta. Bul. 52	U. S. D. A. Farmers' Bul. 1415, "Beef on the Farm"
	Average 3 prime steers	Average	Average	Good steer
	Per cent	*Per cent*	*Per cent*	*Per cent*
Round	21.78	23	24.0	24.09
Loin	16.76	17	17.5	16.38
Ribs	9.77	9	9.5	9.64
Chucks	21.89	26	22.0	22.15
Plates	15.63	13	13.0	14.46
Flanks	5.15	4	[2] 9.0	3.53
Shanks	4.97	4	(2)	5.75
Suet	4.05	4	3.0	4.00
Waste			2.0	

[1] Choice to prime steers will dress out 60 to 68 per cent of live weight. Good steers will dress out 55 to 60 per cent of live weight. Medium steers will dress out 50 to 55 per cent of live weight. Average dressing percentage of all beef cattle slaughtered for beef is about 53.6 per cent. The fore quarters constitute about 52 per cent of the carcass and the hind quarters 48 per cent.

[2] Flanks and shanks are combined in Nebraska bulletin.

Cattle yields: Carcasses chilled two days and cut Chicago style

Cut	Average live weight 1,000 pounds. Percentage of live weight	Cut	Average live weight 1,000 pounds. Percentage of live weight
Loin	9.0	Plate	7.0
Round	14.0	Shank	2.0
Flank	2.0	Shrink	.5
Suet	2.0		
Rib	5.0	Total	56.0
Chuck	14.5		

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Range Cattle Production

Location of Business.—A good water supply, sufficient tillable land for producing winter feed, adequate grazing for as much of the year as possible, and accessibility to market are the chief considerations in choosing a location.

Size of Business.—The average size of 13 ranches out of 40 studied in Texas during the period 1920–1925, inclusive, was 7,000 acres, and the average amount invested in each of these 13 ranches was $104,000. The 13 ranches handled from 300 to 500 cows, or an average of 381 animals per ranch.

Breeding.—On account of the prevalent use of the open range and national forests, it is desirable to have only one breed in any one area. As there is little difference between the beef breeds, it is better to adhere to the breed already established. Improvement can be made most advantageously by the use of good purebred bulls on the best native females, and culling 10 to 15 per cent each year of the old, off-color, and poor breeders, and replacing them with the best of the 2-year-old heifers. As a uniform product sells to best advantage, it is more profitable to use bulls and cows of one type and breed. Cows should be culled closely, and the breeding season should be confined to two to six months, preferably two months.

Bulls.—For use on the range, bulls should be from 2 to 7 years of age, of good conformation, good bone, prepotent, vigorous, with good rustling qualities, hardy, and accustomed to the climate.

Calf crop.—A large calf crop is essential for profitable production. The 10-year average calf crop on the Santa Rita Range Reserve in southern Arizona has been 75 per cent compared with approximately 50 per cent on similar adjacent ranges. The 10-year average on the Jornada Range Reserve in southern New Mexico has been 65 per cent compared with approximately 45 per cent on similar adjacent ranges. These results have been obtained largely because the cattle are provided with plenty of forage, water, and salt; sufficient bulls are used; adequate distribution of bulls is made; and more attention is given to prepotency and vigor, gentling cattle, age of breeding stock, and separating breeding and nonbreeding stock.

Feeding—*Supplemental.*—Grass usually furnishes a balanced ration for fattening stock and also for growing stock when there are sufficient legumes. For growing stock on nonlegume pasture, some protein meal or legume hay is a desirable supplement. In the Southwest, supplements are usually necessary in the spring, which is the critical period of each year.

Winter feeding.—This may be necessary either to take the place of or to supplement grazing. Grazing may be depended upon, except when snow covers the ground, if some grazing has been withheld from use in the summer. Usually it is best to use grazing as long as it lasts and then to feed adequately until grazing will again furnish maintenance. The average cost of winter feed for breeding cows on 17 prairie ranches in Colorado was $2.13. On 24 mountain ranches, the cost was $5.29 per head. In fattening steers, a higher finish can be obtained usually by supplementing with grain, such as barley and corn, but often the high cost reduces the profit. Steers may be fattened on legume hays, beet pulp, and beet molasses, and on grains, where they are produced in sufficient quantities and with sufficient cheapness to allow a profit.

Permanent watering places.—These should not be farther apart than 4 to 5 miles on flat or undulating coun-

try, 3 miles in rolling country, and one-half to 2 miles on rough ranges. Some temporary water should also be available. The water supply should be sufficient to furnish 8 to 10 gallons daily.

Salting.—Systematic salting probably offers the greatest possibilities for improving distribution of cattle on ranges. About 2 to 2½ pounds of salt per head per month is required when feed is succulent or when most kinds of browse form the bulk of the ration. During the remainder of the season 1 to 1½ pounds a month will be adequate. In locating salt grounds, too heavily used areas should be avoided, and salt should be placed at readily accessible places on ridges, benches, and slopes, and in openings in timber and brush, ordinarily at a reasonable distance from water. Salt grounds may be 2 miles apart, but usually 1 mile is better.

Grazing.—(See 11.91.)

Spring and fall range.—It is usually advisable to reserve range for spring and fall use. Large areas of the public domain are chiefly valuable for use at this time. With unrestricted use of these areas, however, feed is usually scarce and loss in condition may be so great that the year's production is seriously affected and becomes uneconomic.

Summer range.—Keep the breeding herd separate from nonbreeding stock, if possible, and provide with abundant palatable feed, water, and salt in order to keep the cattle in thrifty condition. The steer herd should have the best summer pasture available. Wherever practicable, herd bulls and young breeding stock may be given supplemental feed to advantage, especially when the grazing is not the best. Usually this feed should be grain, oil cake, or good hay, such as alfalfa. Soapweed, cacti, and other native plants have also proved valuable in emergencies.

Winter range.—Excessive loss in condition and even deaths in the herd may result unless adequate feed is available to maintain the herd during severe climatic conditions. Attempts to utilize the unregulated public-domain ranges during this period have to a great extent rendered the business unprofitable.

Management.—The number of cows per bull should vary from 12 to 30, according to the roughness of ground, sparseness of grazing, character of the timber or brush cover, and serviceability of the bulls.

Proper distribution of cattle on the range.—This usually involves division of each range unit so as to obtain the use of each part to best advantage, including proper seasonal use, segregation of breeding and nonbreeding stock, and use of all the feed. Distribution may be maintained by proper salting of cattle, development of watering places, construction of fences, making stock trails, and attention by riders.

Brands.—Brands should be of a suitable size and be placed (as on the shoulder) where they will damage the hide as little as possible and yet not defeat the purpose of branding.

Castration.—Calves should be castrated as soon as possible after they are dropped to avoid stagginess.

Dehorning.—Dehorning should be done while the cattle are young, preferably under 1 year. It is important to do this operation in cool weather, avoiding the danger of screw-worm infection, which is greatest during the summer months. Generally speaking, the younger the animal is dehorned, the more valuable will it be as a feeder.

Corrals.—Corrals should be substantial, conveniently located, and of adequate capacity to handle all the cattle on the adjacent range.

Water development.—Springs, wells, tanks or reservoirs, and pipe lines are the main water developments on the range. Springs should be fenced and cleaned out and the water piped to troughs. Where springs are not available the more expensive developments must be considered.

Natural or artificial shelter.—Either natural or artificial shelter is valuable during severe storms. Cattle, and particularly young stock, need shelter from cold winter rains.

Fencing.—On the range of high carrying capacity, fencing is desirable to divide the herd into small groups, such as 50 to 100 cows with 2 to 4 bulls. On large open ranges of medium to poor quality, drift fences are valuable for separating herds of 1,000 or more, for separating breeding from nonbreeding stock, and for forming bull pastures and weaning pastures. Unless fences are carefully planned on a productive basis, they may prove to be expensive nonproducing investments. They should not be expected to take the place of salting and riding. Fences should be of four to five wires to discourage cattle from breaking through.

Dipping vat.—A good dipping vat is a necessity on a cattle ranch. Detailed specifications and bill of materials may be obtained from the Bureau of Public Roads, United States Department of Agriculture, Washington, D. C.

Cooperative handling.—Cooperative handling of cattle makes possible the selection and use of better bulls of a uniform type, reduces expense per head, and contributes to general improvement of herds.

Loss.—Loss is an important factor in increasing the cost of production. This should be minimized by providing sufficient feed, giving adequate care, close culling of aged cows, and giving such other attention to disease and to control of poisonous plants as is practicable. Losses on the Jornada and Santa Rita Range Reserves for 10 years have averaged 1.6 per cent and less than 3 per cent respectively, though 7 and 6 of the years respectively have been below normal.

Laws.—For information on laws affecting the cattle industry, write to the attorney general of any particular State, and to the Bureau of Animal Industry, United States Department of Agriculture, Washington, D. C.

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SHEEP AND GOATS

General

AMERICAN SHEEP RECORD ASSOCIATIONS

Cheviot.—American Cheviot Sheep Society. G. W. Lough, secretary, Hartwick, N. Y.
Corriedale.—American Corriedale Association. W. C. Bond, secretary, Cheyenne, Wyo.
Cotswold.—American Cotswold Registry Association. F. W. Harding, secretary, Wheaton, Ill.
Dorset.—The Continental Dorset Club. J. R. Henderson, secretary, Hickory, Pa.
Hampshire.—American Hampshire Sheep Association. Comfort A. Tyler, secretary, 72 Woodland Avenue, Detroit, Mich.
Leicester.—American Leicester Breeders' Association. A. J. Temple, secretary, Cameron, Ill.
Lincoln.—National Lincoln Sheep Breeders' Association. D. T. Knight, secretary, Marlette, Mich.
Merino.—American and Delaine Merino Record Association. Gowdy Williamson, secretary, Xenia, Ohio.
Rambouillet.—American Rambouillet Sheep Breeders' Association. Dwight Lincoln, secretary, Marysville, Ohio.
Oxford Down.—American Oxford Down Record Association. W. A. Shafor, secretary, Hamilton, Ohio.
Romney.—American Romney Breeders' Association. Mark Havenhill, Woodland, Calif.
Shropshire.—American Shropshire Registry Association. Julia M. Wade, secretary, La Fayette, Ind.
Southdown.—American Southdown Breeders' Association, W. L. Henning, secretary, Pennsylvania State College, State College, Pa.
Tunis.—American Tunis Sheep Breeders' Association. Raymond Hays, secretary, Bainbridge, Ind.
Fur Sheep.—American Fur Sheep Registry Association. Henry Hoffman, secretary, Lock Box 779, Syracuse, N. Y.

AMERICAN GOAT RECORD ASSOCIATIONS

Angora.—American Angora Goat Breeders' Association. Miss Claudine Bourland, secretary, Rocksprings, Tex.
Milk Goat.—American Milk Goat Record Association. Will L. TeWalt, secretary, Vincennes, Ind.
Nubian.—International Nubian Breeders' Association. Archie C. Talboy, secretary, La Jolla, Calif.

EXHIBIT CLASSIFICATION

Breeding sheep:
(1) Ram 1 year and under 2.
(2) Ram under 1 year.
(3) Ewes 1 year and under 2.
(4) Ewes under 1 year.
(5) Champion ram.
(6) Champion ewe.
(7) Pen of three ewes 1 year and under 2, bred by exhibitor.
(8) Pen of four lambs (either sex) bred by exhibitor.

Breeders' flock:
One yearling ram, two yearling ewes, and two ewe lambs, all bred by exhibitor.

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Score card for mutton sheep

Scale of points	Possible score
General appearance (25 points)	
Weight: Pounds	5
Form: Straight top and underline, deep, broad, low set for breed, compact, well proportioned	10
Quality: Hair fine, bone fine but strong, features fine but not delicate, skin pink	10
Condition (12 points).	
Flesh covering: Deep, even, firm. Points indicating finish are fullness in shoulder and brisket, thick covering over top of shoulders, back, ribs, loin, thick dock	12
Head and neck (9 points).	
Head: Clean-cut, strong mouth, thin lips, large nostrils, large, clear eyes, alert look, face short, forehead broad, ears alert and not coarse, considerable width between ears	5
Neck: Short, thick, smoothly joined with shoulder	4
Fore quarters (10 points).	
Shoulders: Compact on top, smoothly joined with neck and body, and well covered with flesh	8
Brisket: Full, round, and well extended	1
Legs: Straight, short, wide apart	1
Body (18 points).	
Chest: Deep, wide, full	2
Ribs: Well sprung, long, close, and thickly covered	4
Back: Broad, straight, thickly and evenly covered with flesh	6
Loin: Wide, thick, well covered	6
Hind quarters (17 points).	
Hips: Wide apart, level, smooth	1
Rump: Long, level, wide and thick at dock	4
Thighs: Full, deep, wide	4
Twist: Deep, firm, plump, joined well down on leg	5
Legs: Straight, short, strong, wide apart	1
Udder or scrotum: Ewe's udder well formed, large and soft. In rams, both testicles large and well developed	2
Wool (9 points).	
Quantity: Long, dense, even in density and length	3
Quality: Crimp distinct and even, oil uniformly distributed throughout fleece	3
Condition: Strong in fiber, clean, soft, and bright	3
Total	100

Sheep

Type and Breed Percentages.—According to the 1920 census, 54.1 per cent of all the purebred sheep in the United States were of the medium-wool breeds, 42.2 per cent were of the fine-wool breeds, and 3.7 per cent of the long-wool breeds. Shropshires made up 31.5 per cent of the purebreds, Rambouillets 27.07, merinos 15.17, Hampshires 13.13, Oxfords 4.20, Lincolns 3.51, Dorsets 2.13, Southdowns 2.12, Cheviots 0.75, Leicesters 0.19, and Suffolks 0.18 per cent. The other breeds were not reported separately.

Mutton and lamb.—The production of sheep for wool alone is rapidly passing, and more and more emphasis is being placed on the production of lamb and mutton for the table. Lamb is the meat from sheep under 1 year old, and mutton is the meat from sheep fully 1 year old or older. Most Americans prefer lamb to mutton,

and the price of lamb is usually very much higher than the price of mutton.

Wool.—The official wool standards of the United States for grades of wool are fine, one-half blood, three-eighths blood, one-fourth blood, low one-fourth blood, common, and braid. These grades are named in the order of fineness, fine being the finest and braid the coarsest. This classification of wool grades is based entirely on fineness or diameter of fiber.

Wool from mutton sheep, such as Shropshires or Hampshires, usually shrinks in scouring about 45 to 55 per cent, and fine wool from Rambouillets and merinos shrinks about 55 to 65 per cent, although the extremes in wool shrinkage may range from 20 to 80 per cent. The loss in shrinkage consists of dirt and other foreign material in addition to natural wool oil.

Goats

General.—Improved types of goats have been developed primarily for the production of either mohair or milk. The Angora is the only breed that produces mohair, and in America the most important milk-producing breeds are the Toggenburg, Saanen, and Nubian. Although goats have not been improved primarily for meat production, their flesh is wholesome and the meat from young kids is relished by some people. Goats do not gain in flesh as rapidly as mutton lambs, and therefore are more valuable for their fleeces or milk than for meat.

Goat meat.—The production of goat meat in the United States has amounted to approximately 3,000,000 pounds per year during the years 1923 and 1924, or about seventeen one-thousandths of 1 per cent of all meat produced in the United States. The average carcass is not susceptible of so high a finish, and goats do not yield so high a dressing percentage as sheep average.

Goat meat generally goes into the regular mutton trade, as there is only an occasional municipal restriction against such practice. In cities and towns adjacent to the southwestern goat range Angora wethers are freely marketed as such, and the meat is consumed without discrimination by the buyer. A characteristic sweetness of properly finished goat meat is the reason given by a few consumers for their ability to distinguish between mutton and goat meat. Angora goat breeders are attempting to popularize goat meat by giving it the name "chevon."

Goats' milk.—Goats' milk is nearly always pure white in color. The small size of the fat globules is one of its chief characteristics. The cream rises very slowly and never so thoroughly as in cows' milk. However, tests by the Department of Agriculture have shown that the butterfat of goats' milk can be so thoroughly removed when it is run through a cream separator that only 0.03 per cent of butterfat remains in the skim milk. Goats' milk that is properly produced and handled has no goaty flavor or odor. The principal source of bad flavor and odor in the milk is the dirt and hair that fall in from the body of the animal. Then again the goaty odor is often absorbed by the milk when the milking is done near where the bucks are kept.

Goats' milk can be utilized for the same purposes as cows' milk, although for some purposes it is not nearly so well suited. For general use, such as for drinking, cooking, and using in tea and coffee, it has proved very satisfactory. It can also be evaporated and sold in that form. It is less satisfactory than cows' milk for making butter, but large quantities of goats'-milk cheese

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are manufactured, especially in Europe. Practically all publications dealing with milk goats attribute considerable importance to the use of the milk for infants and invalids.

A doe that produces 3 pints of milk per day is considered only a fair milker; the production of 2 quarts is good, and 3 quarts is considered excellent, provided the lactation period is maintained for a period of 7 to 10 months.

Mohair.—Mohair is the fleece of the Angora goat. During 1924 its production in the United States amounted to 10,043,000 pounds, and 8,471,000 pounds of it was produced in Texas. New Mexico produced 300,000 pounds, Arizona 500,000, California 180,000, Oregon 450,000, and Missouri 142,000 pounds. Mohair is used for car upholstering, and in the manufacture of superior suit linings, suitings for men's summer wear, portières, robes, rugs, braids, and artificial furs. Some of the longest of it is made into ladies' switches, dolls' hair, and theatrical wigs.

Mohair from young kids is the finest, and it is especially desired by the mills. Buck fleeces are the coarsest, and grow more so with the age of the animals. The value of mohair depends upon its length, fineness, luster, density, and freedom from kemp (a coarse, harsh fiber). Most mohair is of about six months' growth, and to comply with the manufacturers' usual requirements it should be at least 6 inches long.

A limited quantity of mohair is grown to extreme lengths of about 20 to 30 inches or more by allowing goats that do not shed to carry their fleeces without shearing for two or three years. Extremely high prices, ranging from $9 to $20 a pound, have been paid for some of this long mohair that is fine, lustrous, and free from kemp. However, it is nowhere produced on a large scale, and it constitutes only an interesting incident in mohair production.

Feeding

Mineral Requirements.—Sheep require salt, and it should be available to them at all times. An irregular supply induces overeating of it, which may result in scours. Calcium and phosphorus are the principal minerals (other than salt) required by sheep, but these two minerals are contained in protein-rich feeds, especially legume hay. Sheep that receive well-balanced rations containing a liberal allowance of good clover or alfalfa hay should require only salt as their mineral supplement. If legume hay is not available the calcium and phosphorus can be supplied by the mixing of bone meal and rock phosphate with the salt.

Rations—*Breeding ewes.*—Each of the following rations furnishes approximately the quantity of the various nutrients required daily for ewes weighing from 120 to 145 pounds:

Ration No. 1

2 pounds alfalfa or cowpea hay.
2 pounds corn silage.
½ pound shelled corn.

Ration No. 2

2 pounds alfalfa hay.
2 pounds corn stover (quantity eaten).

Ration No. 3

2 pounds alfalfa hay.
2 pounds corn silage.

Ration No. 4

1 pound oat straw.
2 pounds corn silage.
¼ pound linseed meal.
½ pound corn.

Breeding rams.—Breeding rams need to be in good condition, especially during the breeding season. Good legume hay with a partial allowance of straw and cornstalks may be sufficient for rams that go into winter in good condition, and good pasture may furnish their requirements up to about one month before the beginning of the breeding season, when they should receive some grain. Two parts oats and one part bran, by bulk, make an excellent mixture. Oats alone are also very good. If the rams are thin the following mixture, by weight, is excellent: Corn, 5 parts; oats, 10 parts; bran, 3 parts; and linseed meal, 2 parts. Rams should be fed about the same quantity per 100 pounds live weight as breeding ewes.

Fattening sheep and lambs.—Under the conditions of modern sheep production the majority of fattened sheep go to market as lambs under 1 year old, and many of them at less than 6 months old. Winter and spring lambs are fed grain in creeps. Until lambs are 5 to 6 weeks old their grain should be coarsely ground or crushed. Corn is a good feed for lambs that are to be marketed at 3 to 5 months of age, but when the price of corn is relatively high, or good-quality legume hay is scarce, the following mixture has been found very good: Corn 5 parts, oats 2 parts, bran 2 parts, and linseed meal 1 part by weight. Linseed meal is especially relished by lambs at this time and it is valuable for promoting growth rather than fat. Choice alfalfa or clover hay should also be fed in the creep. The quantity of grain that should be fed to young lambs will vary according to their age. From the time they are 5 or 6 weeks old until they are weighing 65 to 75 pounds they should be allowed as much as they will clean up readily. This quantity will range from about one-eighth to three-fourths of a pound and sometimes a full pound per day.

Weaned lambs, especially feeder (unfinished) lambs, from the western range are fattened in cornfields, open yards, or barns during the fall and winter months. Those fed in the cornfields need to have access to forage or grass other than the corn plant, or in the absence of such forage or grass good clover or alfalfa hay may be fed as the roughage and protein supplement. Corn and legume hay are the principal feeds for fattening lambs in yards and barns, but oats are best for starting lambs on a grain feed. In the absence of high-quality legume hay the grain mixture should consist of about 65 to 70 per cent corn, 25 per cent oats or bran, and 5 to 10 per cent linseed meal by weight. The exact proportions for the grain mixture will depend on the quality of the roughage, age or degree of finish of the lambs, and the prices of the various feeds.

Lambs that are placed on fattening rations when weighing 55 to 60 pounds and finished in about three months at 80 to 85 pounds require an average daily allowance per head for the period of approximately 1½ pounds of grain and 1½ pounds of high-quality legume hay. At times feed prices may justify less grain and more hay. Corn silage that is fed to lambs must be of high quality and free from mold. The daily allowance of silage should not exceed about 1 to 1½ pounds.

Growing sheep.—Sheep that are to be grown for breeding purposes should not be fed fattening rations. Oats, or a mixture of 2 parts oats and 1 part bran by bulk, are more satisfactory than corn alone as grain for growing sheep, although corn may be fed in a mixture of 5 parts corn, 10 parts oats, 3 parts bran, and 2 parts linseed meal by weight. Grain may be unnecessary for

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growing sheep that are on excellent pasture or that have an abundance of choice legume hay. In the absence of good pasture or hay the daily grain requirement will vary from about one-fourth pound to a full pound per head, depending on the age, size, and condition of the sheep, as well as upon the kind and quantity of roughage or pasture they receive.

Water.—Sheep frequently suffer from thirst A sheep needs from 1 to 6 quarts of water daily, depending on the feed received, the weather, and the condition of pasture.

Management

General.—The logical beginning of the sheep year is in the fall, at breeding time. At this season it is customary to dispose of the cull ewes that are too old, those that have spoiled udders, those that are undesirable either in fleece or form, and the ewes that fail to produce lambs or that are producing inferior lambs. It is usually possible to purchase good ewes at the most reasonable prices at this season.

Estimation of age by teeth (sheep).—The time of eruption of the permanent incisors provides a rather accurate method of determining the age of sheep. There are four pairs of them, all in the lower jaw, and they may be expected to come in about as follows:

Teeth	Age of eruption
First or middle pair	12 months.
Second pair	24 to 27 months.
Third pair	33 to 37 months.
Fourth pair	48 months.

From the age of 5 to 7 years loose and missing teeth may be observed ("broken mouth"), and after 7 years most of the teeth will be gone ("gummers").

Castration and Docking.—Lambs that are to be sold for slaughter at public stockyards where there is considerable competition should be docked and castrated to insure ready sale at the highest price for lambs of the grade in question. Furthermore, wether lambs are less apt to worry and reduce rate of gain on ewe lambs in the flock than are ram lambs. Docked lambs of a given grade always present a more attractive appearance to the buyer than lambs that have long tails. Docking also aids in the prevention of maggots and the general sanitation of the flock. Dock and castrate lambs when they are 1 or 2 weeks old.

Flushing.—During the breeding season the ewes should be kept in a gaining condition. This will usually necessitate an extra good pasture, or grain in case pasture is not available. This extra feeding should be started two or three weeks before the rams are turned with the ewes and should be continued for about two months, or until all ewes have been bred. In 10 years of experimental work on this subject the Bureau of Animal Industry obtained 164 more lambs per 1,000 as a result of "flushing" or extra feeding at breeding time.

Identification.—(See .254.)

Lambing.—During the lambing season it is essential to provide for attention of the lambing ewes at all times of day and night to insure saving the maximum number of lambs. Individual lambing pens are needed to prevent some of the ewes from disowning their lambs and to protect newborn lambs from danger in the flock. Provide plenty of good feed for the ewes while they are nursing their lambs to make sure of a good milk flow and thrifty, rapid-growing lambs. Lambs born out of pasture season need, by the time they are 2 or 3 weeks old, a little grain, such as a mixture of cracked corn, oats, and bran, about equal parts by weight, and choice leafy clover or alfalfa hay in a creep where they can eat without being bothered by the old ewes.

Sanitation.—Fresh pastures are very important in the production of thrifty lambs. In case it is necessary to use permanent pastures where sheep have been kept for two or three years the old ewes should be drenched for the prevention of stomach worms before being turned onto the pasture, and the lambs should be drenched if they are to be kept after weaning time. Much can be accomplished in the control of sheep parasites if the flock is changed to a fresh pasture every two weeks. Parasites trouble the lambs even more than they do the mature sheep, and wherever practicable lambs should be kept on fresh pastures.

Shearing.—Shear only when the fleeces are dry, and keep the shearing floor well swept. In tying the fleeces roll them up neatly, flesh side out, and tie with paper fleece twine. Remove and sack separately all tags, and allow no tag discount on the clip as a whole. Sack black and gray fleeces separately.

Farm Mutton Supply

Meat Yields of Lamb.—Lamb round-dressed, chilled seven days, and cut as follows: Flank, plate, foreleg to stew, forerib, shoulder with neck off, no ribs in the loin cut, leg off through hip bone, will give, in trimmed state, the yields shown in the table.

Meat yields of lamb

Cut	Live weight 80 pounds. Percentage live weight	Cut	Live weight 80 pounds. Percentage live weight
Leg	13.0	Kidney fat	1.5
Rib	7.0	Fat trimmings	2.5
Loin	5.0	Shrink	1.0
Shoulder	10.0		
Stew	8.0	Total	49.5
Neck	1.5		

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Range Sheep Production

Location of Business.—The ranges, winter-feeding grounds, and lambing grounds should be so located as to avoid long trails.

Size of Business.—*As a sole business.*—Range-sheep production, when handled as a single business, requires approximately 4,000 to 5,000 breeding ewes in order to furnish sufficient net income for a substantial managerial wage. Range production of lambs and wool with less than 800 to 1,000 breeding ewes is not profitable. The investment for handling a small band of this number will range from $15,000 to $18,000 and return a net yield of $450 to $900, or 56¼ cents to 90 cents per ewe. For 4,000 to 5,000 ewes the investment would be approximately $50,000 to $75,000, and with the same returns as above the manager would receive an annual net wage of $2,250 to $4,500.

As a major enterprise.—When sheep production is not the sole business, but is a major enterprise, it will require at least 2,000 ewes in order to avoid excessive overhead expense.

Breeding—*Types and breeds of range sheep.*—Sheep of the fine-wool type are found in all parts of the range area. A large percentage of the ewe stock on the range has at least some fine-wool inheritance. The Rambouillet is the most popular fine-wool breed in the West, although the Delaine-Merino is still represented, especially in regions where wool growing is more of a specialty than market lambs. Of the mutton type, the Hampshire is the most popular of the established breeds on the range. Hampshire rams are extensively used for mating with fine-wool or crossbred (long-wool fine-wool) ewes in range sections where feed is abundant and finished market lambs are produced on the range. During the last 10 years much effort has been spent in attempts to establish crossbred types adapted to the range conditions. Corriedales, founded on a Lincoln-Merino cross, have been imported from New Zealand. In Wyoming and Idaho the United States Department of Agriculture has been working on the interbreeding of Lincoln rams and Rambouillet ewes, the type produced being known as Columbia. In central Idaho, private breeders have been interbreeding Rambouillet rams and Lincoln ewes, the offspring being known as the Panama. These crossbred types seem to be well adapted to range conditions where feed is sufficiently abundant for the production of finished market lambs. The ewes of the crosses are well suited to the range, and although growing a heavy salable fleece of medium fineness, they produce lambs that mature early and sell to advantage as finished lambs. Lincoln, Cotswold, Leicester, and Romney rams are also used on fine-wool ewes for the production of the crossbreds.

Market lambs.—Hampshire rams and crossbred ewes are used for market-lamb production. The crossbred ewes yield heavier and more salable fleeces than Hampshire ewes when producing lambs under range conditions, and the Hampshire rams sire well-marked lambs that are in demand by butchers and packers. Although the lambs of the crossbred types are not so noted for their excellence of mutton form, they are close competitors of the Hampshire-sired lambs.

Breeding for wool.—On ranges where feed is so sparse that lambs can not be finished, Rambouillets and merinos predominate. The production of wool is valuable, and the salable lambs go largely as feeders. Fleeces of the Delaine-Merinos are noted for extreme fineness and high quality, but Rambouillets also yield wool of high charac-

ter, grading Fine and high Half-Blood. Since Rambouillets have fairly strong mutton tendencies for fine-wool sheep and produce lambs that attain desirable weights at early ages they are finding much favor among ranchmen in the fine-wool regions.

Breeding purebred sheep.—Growing purebred sheep involves greater investment per sheep than does the production of market lambs and wool. Success depends largely upon the selection of sires. Selling purebred sheep is much more complicated than marketing lambs and wool. The breeder must exhibit at livestock shows, carry advertisements in livestock journals, and sell only those animals for breeding purposes that will give a high degree of satisfaction.

Feeding—*Winter feeding of ewes.*—Wherever possible the winter feeding grounds should be conveniently located with respect to the winter range, so that ewes can be moved promptly to winter feed as soon as heavy snows cover the winter grazing. If the fall and winter grazing has been fairly abundant and the ewes go on to winter feed in good condition, they may do as well on good quality alfalfa hay alone until about one month before lambing. When hay only is fed the daily requirement per ewe is 3 to 4 pounds. If hay is scarce, it may be supplemented with oat straw, corn stover, or silage made from either corn or sunflowers. Frozen and moldy silage should not be fed to sheep. Beginning one month before lambing, feed grain to insure a satisfactory milk flow. Oats, oats and barley, or oats and corn are good grain combinations. The daily grain allowance per ewe before lambing is ¼ to ½ pound. After lambing, increase the grain allowance to 1 pound per ewe per day until grazing is available. The quantity of grain fed should be governed by the cost of feed and its relation to lamb and wool prices.

Fattening sheep.—In regions where the valleys produce an abundance of alfalfa and grain, sheep and particularly lambs may be fattened profitably. In some of the lower valleys where corn matures sound ears, lambs have been fattened in cornfields. In sugar-beet valleys, sheep and lambs have been profitably fed on beet tops. Wet beet pulp, dried-molasses beet pulp, and beet molasses may all be used in fattening sheep and lambs. Vegetation of near-by range, alfalfa hay, or some good protein roughage should be supplied in addition to grain and other fattening feeds.

Emergency feeds.—Alfalfa can be grown for hay in most of the irrigated valleys. Straws may be used to some extent, especially oat straw. Oats and barley are grown successfully in the irrigated valleys or where there is sufficient rainfall, and corn is grown to advantage in some places. Considerable corn is shipped in from the Corn Belt to meet the demand. Corn grown in the western valleys is often used for silage and dry roughage. When alfalfa or other legume hays are not available and sheep must get their roughage from straws, corn stover, silage, or prairie hay and when the only grain available is corn, it is essential to feed such protein concentrates as linseed or cottonseed meal, at a daily rate per ewe of ⅛ to ¼ pound. Since these protein concentrates must be shipped in, it is usually cheaper to depend upon alfalfa hay. In recent years sunflowers have been successfully grown on dry range lands, even at elevations ranging from 5,000 to 6,000 feet, where corn does not yield well. Sunflower silage is relished by sheep as well as corn silage.

Water requirement.—Running streams are usually the most satisfactory, but ranges not served with such

streams may have to be supplied by various other means. Sheep will quench their thirst on snow and to a certain extent on heavy dews. Hollow places with rock bottoms may be shaped with plow and scraper so that they will hold water from melting snows and rains for use of the sheep in the spring. Wells with gas-engine pumps may also be used when it is possible to strike water without too much expense.

Salt.—Sheep should have daily access to salt. Scatter handfuls of it on smooth rocks, grass, or hard ground, distributing as much as the sheep will eat. Both coarse barrel salt and rock salt may be used. Many ranchmen prefer the barrel salt, believing that rock salt does not dissolve easily enough and that sheep are liable to break their teeth on it.

Grazing (see 11.91).—*Spring and fall range.*—The spring and fall range should be located within reach of a water supply where vegetation furnishes succulent, palatable grasses and weeds for ewes and lambs in the spring, as well as cured palatable grasses in the fall. Range of this type is frequently found on the open, or desert and sagebrush ranges that are too dry in summer and too cold or too snow-bound in winter for satisfactory grazing of sheep during those seasons of the year. However, in some cases the presence of snow in limited amounts makes it possible to utilize desert range in winter. Spring grazing should be light, thus insuring a good supply for fall grazing.

Summer range.—The best summer range is now in the national forests. The highlands that supply mountain streams throughout the summer, together with plenty of grass and herbs, furnish good grazing for ewes and lambs. The cool summer weather and abundant shade of a desirable summer range are essential for the production of finished market lambs.

Winter range.—The proper winter range will be found in canyons and areas protected from heavy snowfall, but where sufficient snow is found in late fall and winter to furnish moisture to quench the thirst of the sheep. Some of the best winter range is so far from running streams that the roaming livestock can not graze over it during spring, summer, and fall; thus the vegetation is spared for winter use. The winter feeding grounds should be located conveniently with respect to the winter range and the lambing grounds.

Management—*Herding.*—Except when the ewes are suckling their lambs there should be 2,000 ewes or more in the band. This reduces the number of herders needed, as compared with herding when ewes and their lambs are running together. It is desirable to have 1,000 to 1,200 ewes with their lambs per band from lambing time until the lambs are cut out. A good herder is one who can assume considerable responsibility and who has sufficient initiative to adjust his methods of handling his band according to the changing conditions which he is certain to encounter in the course of the year. He must be especially adept in keeping account of the sheep in his band and he needs to be experienced as a cook and a caretaker of his camp. Handle the sheep openly and quietly during the day, and bed down on new ground each night. Avoid bedding or shading about watering places and clumps of timber reproduction. Furnish breeding ewes with the best grazing available at breeding time.

Lambing.—In order to have good lambing grounds, sheep should be protected from overgrazing throughout the year, and yet should be grazed sufficiently to make

possible a good growth of fresh, young, and palatable vegetation at the time of their use for lambing. The grounds should be protected by hills, and should be located where excessive snow melts early in the spring and where spring storms are least frequent.

When the grass is unusually short, provide a supplementary feed of one-fourth to one-half pound of grain per day per ewe. Have well-organized crews during lambing time, so that the lambing ewes can have attention at all times of day and night. In stormy weather, some of the weak lambs will require special attention to be saved from chilling. When lambing during winter or early spring in the Northwest, sheds are desirable. In large lambing sheds much trouble which would be caused by ewes disowning their lambs can be avoided if the ewes and their lambs are placed in individual pens as soon as the lambs come. Dock and castrate the lambs when they are about 1 to 2 weeks old. Furnish the ewes with plenty of good feed as soon as their lambs are a few days old. Such feed should consist of good hay, together with grain, when grazing is not good. Ewes with their lambs make good use of approximately 1 pound of grain per ewe per day when their lambs are 3 or 4 weeks old, provided they have lambed in winter and have access to good grazing on range.

Care of rams.—Keep the rams in thrifty condition throughout the year, but do not overfeed or pamper them. For a month or two before breeding begins, feed grain similar to the mixtures recommended for lambing ewes, so that they will be in prime condition.

Shearing and care of wool.—The time for shearing will vary according to the climate and weather conditions. In the Southwest it is usually started in March, and expert shearers move gradually north, finishing range shearing in the States along the Canadian border about July 1. Convenient shearing sheds and experienced shearing crews are essential. Tie the wool, sack, and store where it will keep dry until shipped. Black fleeces, tags, ewe fleeces, yearling fleeces, and buck fleeces should be sacked separately. In case the band contains both fine-wool and crossbred types, fleeces from each type should be sacked separately.

Corrals.—Construct substantial corrals with "cutting chute" to sort sheep and cut out lambs. Usually four to six divisions are required in the corrals in addition to the dipping vat and accompanying corrals, the shearing shed with its holding pens, sweat pens, and counting-out pens, and branding chute. On the central and northern ranges, where sheds are used for lambing, the accompanying corrals should be arranged so as to permit a gradual building up of groups of ewes with their lambs from the time they leave the individual pens until they are turned in the band on the range. Many lambs have been saved through the practice of first placing the ewes with their lambs from the individual pens in groups of 10, then when the lambs are sufficiently mothered after two or three days in small-group pens, they are put into groups of about 50 ewes with their lambs and later into groups of 100.

Dipping vats.—Detailed specifications and bill of materials may be obtained from the Bureau of Public Roads, United States Department of Agriculture, Washington, D. C.

Camp outfit.—The camp outfit is the sheep herder's home, and comfortable, well-equipped camps are essential for dependable and efficient herders. The camp wagons should have a durable running gear and weather-proof

canvas cover. There should be plenty of room under the cover for the bed, a small cook stove, cooking utensils, and combination cupboard and table. The modern herder demands a variety of good food. He needs a gentle saddle horse. He also needs a tepee tent for sleeping near the band when far from camp. A camp tender is needed for every two or three herders. It is his duty to haul supplies to the camps, move the camp wagons, occasionally cook, straighten up camp for an extra busy herder, and at times tend sheep for a herder who is ill or on a short vacation. The camp tender is also charged with considerable responsibility as a messenger between the foreman or manager at headquarters and the herders.

Management of purebred sheep.—Give them more care and attention than is usually necessary for range sheep kept solely for the production of market lambs and wool. In order to register purebred lambs, it is necessary to penbreed the ewes so that their exact parentage can be determined. Many of the rams and ewes that the purebred breeder will purchase for his operations are raised under protected and somewhat artificial conditions. It is necessary for him to continue their protection at least for a time before subjecting them to hazardous range conditions. In order to keep the breeding record, the purebred lambs must be identified at the lambing pens and earmarked with individual designations. When the lambs are about 4 months old, remove the ram lambs from the flock in order to avoid their breeding out of season. Breeders usually sell rams as yearlings rather than lambs. This necessitates carrying over the ram lambs and handling them separately and, in some cases, giving them special care if they are to be fitted for the purebred trade.

Cooperative management of small flocks to utilize range.—The pooling of moderate-sized flocks for making up full-sized bands for herding on the range requires loyalty of cooperators to each other and to the group arrangement. Without a high degree of such loyalty failure is almost certain. Cooperative management of flocks requires a thorough system of flock identification by earmarks or paint brands. When owners engaging in such cooperation buy flocks of sheep they will find an advantage in sheep raised on the range over sheep raised in farm flocks because of the better herding habits of range sheep. It is essential to include in the flocks animals as nearly of the same type as practicable. Under ordinary conditions the best basis for prorating the expenses of herding and grazing will be on the number of sheep when the value per sheep is fairly uniform for the various flocks.

Laws.—Advice in regard to Federal laws may be obtained from the Bureau of Animal Industry, United States Department of Agriculture, Washington, D. C. Information concerning State laws with reference to disease may be obtained from the State livestock sanitary authorities of the respective States, and inquiries concerning any other State laws may be directed to the attorney general of the State concerned.

Range Goat Production

Location.—Goat range should possess a mixture of browse, grasses, and weeds. The range should be free from continued heavy rains and snow, and well supplied with bed grounds and watering places. Browse is a natural goat feed and should furnish the bulk of their subsistence throughout the year. Grass and weeds

are necessary for does and kids during the spring and summer, but not during the winter, although they give variety to the forage. On extensive areas the brush should be sufficiently open to allow herding of the goats. On small areas the brush may be dense. Water should be available on the range during the spring, summer, and fall. In winter, range having an insufficient water supply may be grazed if snow is available, since goats will quench their thirst on snow. Areas having heavy rains and snows are limited in their suitability for goats. Dry, rugged areas are better suited to goat grazing than wet marshlands. Ranges subject to heavy snowfall should not be used in winter unless dry sheds and plenty of feed are available.

Size of Business.—On true goat range, herds of about 1,200 goats can be handled economically. A study of the costs of running goats in a number of New Mexico range herds shows that the annual cost of running yearlings and wethers, exclusive of interest on investment and owner's labor, varied from 95 cents to $2 per head, and the cost of running does and their kids from $1.62 to $2.78 per doe. Net income from Angora goats will vary from 50 cents to $2.50 per mature goat per year. A herd of 1,200 goats should yield a net income, exclusive of interest on investment and owner's labor, of $900 to $1,200. Larger herds are required to furnish a substantial managerial wage. In southwestern Texas, where goats are run under fence and with sheep and cattle, smaller herds may be handled, depending on the general organization of the livestock outfit.

Breeding.—Angora goats are especially adapted to the range, and are valuable for production of mohair. Goats of the milk breeds are not adapted to true range conditions. Purebred Angora bucks of good breeding and individuality are needed for profitable mohair production. The time of mating depends largely on the time when it is best for the kids to come. The period of gestation is from 147 to 155 days, and the time of mating is adjusted accordingly. Bucks to be used for breeding should be over 18 months of age. They should be kept in a thrifty, growing condition throughout the entire year, but particularly so during the mating season. Before breeding, clip the mohair from the underside of the buck. When the bucks are turned loose on the range with the herd there should not be more than 40 does to each buck. When the bucks are kept up in the daytime and fed grain in addition to pasturage, and are placed with the does only for the night, a buck can often serve more than 50 does during the season, especially if it is desired to have the kids come well distributed through about 30 or 35 days, as is usually the range practice. Does come in heat about the latter part of August or the first part of September, and unless mated have periods of about three days in heat at intervals of 13 to 19 days until January. Before breeding the mohair should be clipped from the hind parts of the doe well under the tail. The does should be in good condition at time of breeding and should not be bred until they are 18 months of age.

Feeding.—*Supplemental.*—All kinds of hay from alfalfa or clover to dried brush or straw may be fed. Where alfalfa, clover, vetch, or cowpeas are fed, no grain is necessary. However, it is well to supplement rough fodder with cottonseed cake, oats, barley, or other grains. Roots are sometimes fed as a substitute for green feed. Hay should be fed in a feeding rack and grain in troughs, since goats will not eat anything soiled by dirt or trampled. For most range herds, from 1 to 2 pounds of

hay or from one-quarter to 1 pound of cottonseed cake are fed to each goat on days when they are unable to obtain sufficient range feed.

Water.—Provide pure fresh water, and in the Southwest it may be necessary to utilize rain water caught in large storage reservoirs. The goats drink this water when once accustomed to it. Deep wells must sometimes be drilled on southwestern ranges if there is to be a supply of water throughout the year. The cost of such operations is often prohibitive, considering the amount of forage available in the locality. When this is true, such areas are sometimes used only during the rainy seasons and when stored rain water can be used.

Salt.—Goats are more easily handled and thrive better if salted regularly at short intervals than if salted at long intervals. Rock salt is often placed on the bed ground, so that the goats can eat it every night if they desire. Coarse granulated salt is fed either in small quantities every night or in larger quantities at intervals of approximately a week. Place on rocks, in troughs, or in boxes to prevent waste and to keep it clean. The amount of salt fed varies from one-half pound to 6 pounds for each goat per year. A greater amount should be fed when the range is green and succulent than when it is dry.

Grazing (see 11.91).—*Spring range.*—There should be an abundance of grass and weed forage on the kidding range, but there should also be some browse to provide tender, green twigs when drought or a late season prevents a sufficient growth of grass. There should be enough forage so that the goats will be properly nourished during the period they are on it and no part of it overgrazed.

Summer and fall range.—Since the kids depend largely upon their mothers' milk and upon green succulent feed for nourishment during the summer, there should be plenty of grass and weed forage on the summer range.

Winter range.—Should be situated low enough to be out of range of severe storms. Have enough forage protected at other times of the year so that the goats may obtain ample feed during the winter without excessive traveling. The browse areas of the lower elevations generally furnish the best winter forage. Practice has shown that it is best to reserve the feed close to the shed for use during heavy snows and after shearing in the fall or late winter. The goats may be bedded at a number of places about half a mile in different directions from the shed, in order to preserve this feed and prevent overgrazing.

Management—*Herding.*—Allow the goats to graze slowly, quietly, and openly, and hold down the leaders to the rate the rear goats desire to take. As the goats leave the bed ground in the morning turn the leaders in the direction the herder wishes the herd to graze that day. In the warm part of the day most of the goats will take shade under trees and bushes. In the middle of the afternoon turn the leaders into the herd and start toward the bed ground selected for the night. Take the goats back over the same area grazed in the morning and pick up any goats that have remained behind.

Bedding.—The use of the single bed ground by bedding goats on the same grounds every night in the year prevents proper management of the range. A large area is overgrazed and trampled, and the forage on the range is not utilized evenly. The reasons advanced in favor of a single bed ground are its low cost, the advantage of

having the goats at the shed each night, the proximity to water, the supposedly smaller loss from straying, and the difficulty of obtaining herders who will herd under any other method. The use of several bed grounds at different places on the range helps in obtaining more even utilization of the forage over the entire allotment, lessens the concentration of grazing, and makes possible the recuperation of the overgrazed areas. The improvement in the quality and quantity of the forage and the reduction in the trailing and driving of the goats results in better growth of goats and mohair. The bedding-out system is the ideal bedding method. The goats would be bedded wherever night overtakes them. Open, quiet herding would be practiced, and the goats would be allowed several hours of quiet grazing in the cool of the morning and the afternoon and a rest in the middle of the day. It can not be strictly adhered to during kidding, stormy winter weather, and just after shearing.

Shearing.—Angoras are sheared once or twice a year. In the colder climates they are generally sheared once, in March or April. This gives a longer staple and a more valuable fleece than when they are sheared twice during the year, but the amount of mohair from the single clip may be slightly less than from the two clips. In the Southwest many Angoras are sheared in February or March and in September or October. Machine shearing is almost a universal practice. The fleece is rolled, cut side out, but not tied, and the mohair is packed in bags of 4 or 5 feet in length.

Dipping.—Dip twice a year to rid goats of lice, with which they are usually infested. In the winter infested goats will require more feed, and may become thin and produce a poor quality of mohair, and does even may fail to produce kids. Any of the common sheep-dip preparations are satisfactory.

Kidding.—Kidding requires special care. Period is from February 1 to May 1, and may last from 30 to 35 days. Establish a permanent camp near water. A crew of three or four men is necessary to attend the goats properly. One or two men should herd the drop band. Another man should herd the wet band. While not herding, these men may work about the corrals. One other man, usually the foreman of the crew, is needed about the corrals at all times and to direct the work. The staking or toggle system of keeping does and their offspring identified is usually practiced to avoid confusion and disowning of the kids. The pen system, however, has given satisfactory results. Individual kidding pens are useful as a means of allowing a doe to be alone and quiet while giving birth to the kid, for special care if necessary, and for forcing does to accept disowned kids. The kidding grounds should be well drained, and young kids should have the protection of A-shaped boxes. Kids should seldom be kept on the stake more than 10 days. At that age they should be worked out of the staking yard into a small field which will allow more exercise than a small corral. The buck kids not reserved for breeding purposes should be castrated when from a few days to three weeks old. This should be done early on a bright, cool morning and never on a rainy day. Kids are not turned on the range with the does until they are six weeks old. Separation of the does from the kids each morning is facilitated by placing a "jump board" at the gate. A substantial board about 18 inches high will keep the young and weak kids from leaving the corral.

Equipment.—Goat sheds on the range are simple in construction, for lumber is usually scarce. It is custo-

mary to have the sheds low, generally with metal roofs, and boarded on one or two sides. They are used after shearing to protect the goats from cold rains and sudden changes of temperature. Unless protection is available at such times losses of goats are sometimes severe. Five square feet of floor space per animal is ample for range goats, to prevent piling up in time of storm. When goats pile up it is necessary for the herder to break up the masses at once to prevent smothering. Corrals, cutting chutes, dipping vats, and convenient arrangements for shearing are among the most important items of equipment, in addition to the herder's camp outfit and the camp tender's supply wagon.

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HOGS

General

Geographical Hog Centers.—Center of hog production in the United States in 1920: Latitude 38° 55′, longitude 89° 55′; Hamel, Madison County, Ill., a few miles from St. Louis, Mo.

Center of hog slaughter in the United States in 1920: Latitude 40° 52′, longitude 87° 05′; near Collegeville, Jasper County, Ind., about 75 miles southeast of Chicago.

Center of pork consumption in United States, 1920: Latitude 39° 14′, longitude 87° 47′; Melrose, Clark County, Ill., a few miles west of Terre Haute, Ind.

AMERICAN SWINE RECORD ASSOCIATIONS

Berkshire.—American Berkshire Association. E. M. Christen, secretary, 510 East Monroe Street, Springfield, Ill.

Kentucky Red Berkshire Association. W. B. Turley, secretary, Richmond, Ky.

Big Black Pig.—American Large Black Pig Society. W. T. Benton, secretary-treasurer, Lexington, Ky.

Cheshire.—Cheshire Swine Breeders' Association. Edward S. Hill, secretary, Freeville, N. Y.

Chester White.—O. I. C. Breeders' Association. O. C. Vernon, secretary, Goshen, Ind.

Chester White Swine Record Association. F. F. Moore, secretary, Rochester, Ind.

Duroc-Jersey.—American Duroc-Jersey Association. R. J. Evans, secretary, 817 Exchange Avenue, Chicago, Ill.

National Duroc Record Association. J. R. Pfander, secretary, Peoria, Ill.

Essex.—American Essex Swine Association. Mrs. J. J. Lighthall, secretary, 426 North Main Street, Bloomington, Ill.

Hampshire.—The Hampshire Swine Record Association. Loring T. Bunn, secretary, 409 Wisconsin Avenue, Peoria, Ill.

Mule Foot.—National Mule-foot Hog Association. C. C. Kreglow, secretary, Degraff, Ohio.

American Mule-foot Hog Record Association. R. E. Pfeiffer, secretary, 1105 Wyandotte Building, Columbus, Ohio.

Poland China.—American Poland China Record Association. George W. Davies, secretary, Union Stockyards, Chicago, Ill.

National Poland China Record Association. C. J. McCahan, secretary, Moorman Block, Winchester, Ind.

Standard Poland China.—Standard Poland China Record Association. F. L. Garrett, secretary, Maryville, Mo.

Spotted Poland China.—National Spotted Poland China Record Association. F. L. Obenchain, secretary, 600 Wulsin Building, Indianapolis, Ind.

American Spotted Poland China Record Association. Charles W. Slatten, secretary, Jamesport, Mo.

Tamworth.—Tamworth Swine Association. W. T. Barr, secretary-treasurer, Ames, Iowa.

Yorkshire.—American Yorkshire Club. Harry G. Krum, secretary, 471 Fairview Inn, St. Paul, Minn.

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EXHIBIT CLASSIFICATION OF BREEDING HOGS

Single classes:
(1) Aged boar.
(2) Senior yearling boar.
(3) Junior yearling boar.
(4) Senior boar pig.
(5) Junior boar pig.
The same classification for sows.
Championships (boars and sows):
(1) Senior champion.
(2) Junior champion.
(3) Grand champion.
(4) Reserve senior champion.
(5) Reserve junior champion.
(6) Reserve grand champion.
Groups:
(1) Young herd.
(2) Young herd bred by exhibitor.
(3) Aged herd.
(4) Aged herd bred by exhibitor.
(5) Get of sire.

Score card for hogs

Scale of points	Standard for lard-type hogs	Standard for bacon-type hogs
Head and face	4	5
Eyes	2	2
Ears	2	2
Neck	2	3
Jowl	2	2
Shoulders	6	6
Chest	12	10
Back and loin	14	12
Side and ribs	8	12
Belly and flank	4	4
Ham and rump	10	10
Feet and legs	10	8
Tail	1	1
Coat	3	3
Color	2	2
Size	8	8
Action and style	3	3
Condition	2	2
Disposition	2	2
Symmetry of points	3	3
Total	100	100

Feeding

Mineral Requirements.—Mineral substances in the diet of hogs are just as necessary as are the organic matters, protein, fat, and carbohydrates. All vegetable feeds contain certain amounts of sodium, calcium, magnesium, potassium, phosphorus, iron, and sulphur. Cereal grains, however, do not furnish them in sufficient quantities to satisfy the proper requirements for nutrition and growth.

The most essential mineral substance for proper nutrition in hogs is ordinary salt (sodium chloride). Phosphates and carbonates ol lime and magnesium are needed for the development and solidity of bones if normal growth is to be obtained. Since the leaves of plants contain more ash than the seeds and stalks, hogs which are pastured procure much of the mineral matter required, but where pastures are limited or where dry-lot feeding is practiced supplemental mineral feeding is necessary.

At the United States Experiment Farm, Beltsville, Md., the following mineral mixture is giving satisfactory results:

	Pounds
Steamed bone meal	50
Ground limestone or air-slaked lime	25
16 per cent acid phosphate	25
Common salt	5

Very often wood ashes are available, and these may be incorporated in the mineral mixture to advantage. Where wood ashes are added to the above mixture it may be used to the extent of one-third of the mixture by weight.

A mineral mixture should be supplied to hogs in boxes or self-feeders, where it will remain dry and be available at all times. A small separate compartment in the self-feeder used for grain feeding is convenient for supplying minerals.

Rations

Breeding Stock.—*Dry sows* on pasture should be given a light supplemental feed of corn and middlings (shorts). Keep dry sows thin but in good vigor.

Bred sows should be fed to produce a daily gain in weight from breeding to farrowing of ½ to 1½ pounds.

Middlings
Tankage
Mineral mixture } in separate compartments of a self-feeder.

Feed alfalfa or other legume hay in racks, when not possible to keep sows on good pasturage. Corn should be hand-fed in necessary quantities to supplement the above feeds and obtain the amount of gains advised.

Feeding during pregnancy should be liberal, but not so heavy as when the pigs are being suckled. A very fat sow produces pigs low in vitality, and she will be clumsy with them. A thin sow, on the other hand, can not nourish an average litter of pigs properly.

During pregnancy the sow should receive feeds containing plenty of protein, mineral matter, and water. She should have comfortable quarters, be allowed plenty of room for exercise, and be kept free from lice and worms.

Her grain ration should be fed dry, and toward the close of the gestation period it may be advisable to feed some linseed meal or a small quantity of ground flaxseed.

During the winter root crops are excellent to take the place of pasture and to furnish succulence.

For three or four days before farrowing the sow's feed should be reduced somewhat.

The sow should have no feed the first 24 hours after farrowing, but should be liberally supplied with warm water; then a thin slop of bran and middlings may be given.

For three or four days the feeding should be light, and full feed should not be given for a week or 10 days.

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If the pigs scour, the sow is being overfed. If this trouble appears discontinue feeding the slop to the sow, and give a small quantity of oats scattered thinly on the floor. Dissolve a piece of rock lime slightly smaller than a baseball in a gallon of water; drain the water off the slaked lime and give it to the sow to drink; also bathe the sow's udder and teats with the limewater. In addition give the pigs (on the tongue) 1 drop of formalin solution prepared by mixing 1 ounce of standard-strength formalin and 1 pint of water. Also, the sow's teats may be washed once or twice daily with a solution of formalin prepared by adding 1 ounce of this mixture to a second pint of water.

Young boars selected for the breeding herd should be carefully fed during the growing period.

Supply good pasturage or legume hay in racks with available water supply.

Hand feed a mixture similar to the following to keep them in good flesh, but do not permit them to become fat:

Corn	30 parts.
Middlings (shorts)	35 parts.
Ground oats	30 parts.
Alfalfa meal	5 parts.

Mature boars between breeding seasons should be kept on pasturage of good quality or legume hay in racks, and fed middlings (shorts). Corn may be hand fed in quantities necessary to keep them in good physical condition.

Mature boars during breeding season should be kept on pasturage of good quality if possible, or fed legume hay in racks. Hand feed a mixture of—

Corn	4 parts.
Middlings (shorts)	5 parts.
Tankage (60 per cent)	1 part.

Feeding Young Pigs.—The first opportunity to force growth of the young pigs comes when they are about 3 weeks old, when a creep should be provided in the sow's pen or pasture. Shelled corn should be provided in a trough or self-feeder. When the pigs are 5 or 6 weeks old middlings or shorts, tankage, or fish meal should be provided in a separate trough or self-feeder.

Weaning Young Pigs.—The young pigs should be weaned when from 10 to 12 weeks old, depending on the conditions of the pigs and sow, and whether the sow is to raise two litters a year. It is important that the pigs be eating grain before being weaned.

Weaning should be complete. Do not return the sow to the pigs. Also do not change the ration of the pigs when weaning. If skim milk is available it may be added, but in limited quantities. Any abrupt change in the diet should be avoided.

Good pasture is always advisable for young pigs.

Feeding Breeding Pigs.—Pigs to be kept for breeding purposes should be fed with the whole object of making them stretch out and develop bone and muscle in place of fat. After young gilts have been bred they must be fed a ration heavy enough to develop the litter and properly finish their own growth.

Feeding Fattening Hogs.—After weaning, the pigs to be fattened are fed in two weeks: (1) The growing period, from weaning until within six weeks to two months of the marketing date, and (2) the finishing period, from that time up to marketing.

When sows and pigs are removed from the farrowing houses, about 10 days after farrowing, self-feeders containing corn, tankage, middlings (shorts), and mineral mixture should be available to them in pasture fields containing a good water supply.

When the pigs are about 5 weeks old 60 per cent tankage or fish meal should be added in another compartment of the feeder.

At weaning time (preferably 10 or 12 weeks after farrowing) the sows should be removed and the pigs fed on corn, tankage, or fish meal and mineral mixture, and pasture when it is available, until they reach market weights.

The ration during the growing period is much the same as that given breeding stock, except that more grain should be allowed. Plenty of pasture should be available. When grain is fed on pasture more success is had if a quantity equal to 3 per cent of the body weight is given than if animals are fed smaller quantities.

Much more corn and less protein concentrates are fed during the finishing period. A good ration would contain 10 pounds of corn to 1 pound of tankage. The change in the ration must be gradual and the increase in feed not too rapid, in order to keep the pig from going off feed.

Pastures furnishing plenty of protein, such as alfalfa and clovers, are excellent at this time to keep the pigs' appetites keen.

Management

The following results were obtained at the United States Animal Husbandry Experiment Farm, Beltsville, Md., from 39 sows bred for spring, 1924, litters. After breeding these sows were wintered in a wooded lot containing approximately 10 acres, practically devoid of pasturage, though water and a small quantity of mast were available.

Total number of sows bred	39
Total number of sows farrowing	32
Hog days during period per sow (from date of breeding to three days before due to farrow)	104.3
Average initial weight per sow ....pounds	287.59
Average final weight per sow ....do	450.95
Average daily weight increase per sow ...do	1.567
Average total daily feed consumption per sow	9.852

Corn consumption	0.905 pounds at 1¾ cents
Middlings consumption	8.064 pounds at 1¾ cents
Tankage consumption	.692 pounds at 3 cents
Alfalfa hay consumption	.108 pounds at 1½ cents
Mineral mixture consumption	.082 pounds at 3 cents
	9.852

Average feed cost per sow per day ......cents	18.2
Average number of pigs farrowed per sow	8.78
Average weight of pigs at farrowing ....pounds	2.76
Average cost per pig when farrowed	$2.63
Average number pigs weaned per sow	5.65
Average weight of pigs weaned ....pounds	28.77
Average cost of pigs weaned at 71 days	$6.57

Hog-Lot Equipment.—Plans and bills of material for the following items of hog-lot equipment are available through the Animal Husbandry Division, Bureau of Animal In-

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dustry, United States Department of Agriculture, Washington, D. C.: (1) Barrel waterer; (2) breeding crate; (3) creep; (4) farrowing house (northern); (5) farrowing house (southern); (6) flat-bottomed trough; (7) gate; (8) hayrack; (9) hurdle; (10) individual house; (11) loading chute; (12) self-feeder; (13) shipping crate; (14) shade; (15) wallow.

Self-Feeders for Hogs.—Self-feeders are valuable for feeding hogs for market. They have the following advantages: (1) Hogs consume feed more rapidly and make larger daily gains; (2) they reach a marketable size at an earlier date; (3) there is an actual saving in the quantity of feed required to produce 100 pounds gain; (4) the self-feeder saves labor in hog feeding.

Two methods are practicable in using self-feeders for hogs. The grain and protein supplement may be mixed and fed from the same hopper or they may be fed separately and the pig allowed to choose for itself. The latter method is preferred. Experiments show that the pig usually balances its ration properly and eats relatively less of the high-protein feeds as it gains in weight. However, if the pigs do not appear to be eating the proper proportions of each feed the feeds should be mixed for them.

Though sometimes used for sows suckling pigs, self-feeders ordinarily are not used for breeding hogs, because the hogs are likely to become too fat.

Identification (Tags and Marks).—(See .254.)

Farm Pork Supply

Hog Yields.—Hogs dressed head on, leaf in, chilled two days, cut as follows: Short-cut hams, full-cut head, full three-ribbed shoulder, closely trimmed clear belly, regular loin, lard fat skinned, yield in approximate accordance with the tables below:

Hog yields

Cut	Live weight 180 pounds. Percentage live weight	Live weight 250 pounds. Percentage live weight
Ham	14	13.5
Shoulder	13.5	13.5
Belly	10	10.5
Loin	10	9.5
Sausage	3	3
Ribs	3	3
Rendered lard	10.5	14
Heads	7.5	7
Skin	2	2
Feet	2	2
Scrap	1	1
Shrink		
Total (per cent)	76.5	79

Heads.—Heads from hogs average live weight 180 pounds, dressing 80 per cent, will average about 13½ pounds each.

Head yields

Part	Percentage of head	Percentage of head
Dixies	26	
Meat and bones for headcheese	60	Cold headcheese, 45.
Teeth, nose, etc.	14	
	100	

Smoking Meats.—All surface moisture should be dried off the cured meat before the fire is started. Do not allow the temperature of the room to run above 120° F. Keep ventilators open enough to provide free circulation of smoke around and past the meat. Hams and shoulders require from 30 hours to several days for proper smoking, and bacon about 30 hours.

Sugar Cures—(1) *Dry Methods.*—(*a*) For hams and shoulders; ingredients for 100 pounds trimmed meat:

Salt	pounds	8
Sugar	do	2
Saltpeter	ounces	2

Time necessary for cure, 2 days per pound of meat.

(*b*) For bacon; ingredients for 100 pounds trimmed meat:

Salt	pounds	4
Sugar	do	1½
Saltpeter	ounces	2

Time necessary for cure, 1½ days per pound of meat.

Application: Mix the ingredients thoroughly. Use one-half the mixture when the meat is first packed, one-quarter three days later, and the balance on the fifteenth day. Rub it on and into the meat thoroughly, pack the cure into crevices, especially shanks and butts, and pat or pack it on the faces.

(2) *Brine method.*—(*a*) For hams and shoulders; ingredients for 100 pounds trimmed meat:

Salt	pounds	9
Sugar	do	2
Saltpeter	ounces	2
Water	gallons	5

Time necessary for cure, 4 days per pound of meat.

(*b*) For bacon; ingredients for 100 pounds trimmed meat:

Salt	pounds	7
Sugar	do	2
Saltpeter	ounces	2
Water	gallons	5

Time necessary for cure, 2½ days per pound of meat.

Application: Both pickle and meat should be chilled to 36° to 40° F. when the pack is put down. The pieces of meat should be fitted closely together without being jammed. Overhaul on the fifth, fifteenth, and thirtieth days after putting down, using the same pickle. The

brine method will give bacon a milder cure than the dry method.

(*c*) For beef; use the brine method given for hams and shoulders. Corned plates are palatable after 10 days' cure, and should be well cured in 30 days.

Pork-Sausage Recipe.—Ingredients for 100 pounds pork trimming, approximately one-third fat and two-thirds lean:

Salt	pounds	1¾
Sage	ounces	3
Black pepper	do	3

If desired, the following may be added:

Red pepper	ounces	½
Nutmeg	do	1
Cloves	do	1
Sugar	do	12

Mix the seasoning and trimmings together, and grind twice to insure proper mixing and fineness. Many prefer a $\frac{3}{16}$-inch or ⅛-inch plate. Chill as soon as possible after grinding, as the process heats the meat.

POULTRY

General

NATIONAL POULTRY ASSOCIATIONS

Leghorns:

American Rose Comb White Leghorn Club. J. M. Chase, secretary, Wallkill, N. Y.

American Rose Comb Brown Leghorn Club. C. H. Coleman, Patchogue, N. Y.

American Single Comb Brown Leghorn Club. G. C. Gresham, Parkville, Mo.

American Buff Leghorn Club. H. O. Dittmar, 1027 Teutonia Avenue, Milwaukee, Wis.

American Leghorn Club. Norman L. Kisling, Bel Air, Md.

American Black Leghorn Club. Emil G. Glasser, 1535 H Street, Lincoln, Nebr.

American Silver Leghorn Club. John Hansens, Route 3, Box 723, San Diego, Calif.

National Single Comb White Leghorn Club. Alma Leona Brown, Burlington, Wis.

Buff Leghorn Club. Floyd Purdy, Route 1, Tomah, Wis.

Rocks:

American Barred Plymouth Rock Club. L. T. Robinson, Union City, Mich.

American Buff Plymouth Rock Club. J. A. Legore, Le Gore, Md.

American Columbian Plymouth Rock Club. J. H. Breitigan, Lititz, Pa.

American White Plymouth Rock Club. G. A. Krueger, Plummer, Minn.

International Partridge Plymouth Rock Club. J. H Webster, Buffalo, N. Y.

American Rose Comb Barred Rock Club. W. S. Hoke, Rosiclare, Ill.

Rhode Island Reds:

Rhode Island Red Club of America. A. G. Studier, Waverly, Iowa.

Rhode Island White Club of America. Mrs. Eva Genoway, Fredericktown, Mo.

American Silver Penciled Rock Club. Peter Jungels, Lemont, Ill.

Wyandottes:

American Buff Wyandotte Club. J. M. Clark, Pawlet, Vt.

National Partridge Wyandotte Club. J. F. Tallinger, R. F. D. 6, Dewey Station, Rochester, N. Y.

National Black Wyandotte Club. Bradley Cook, Oley, Pa.

National Columbian Wyandotte Club. Henry W. Polgreen, 128 State Street, Albany, N. Y.

National White Wyandotte Club. E. B. Rose, East Stroudsburg, Pa.

International Black Wyandotte Club. Ralph Roudebush, Hope, Ind.

International Golden Wyandotte Club. Melvin F. Uphoff, Williamsport, Pa.

International Silver Penciled Wyandotte Club. Fred F. Field, jr., 45 Emerson Avenue, Montello, Mass.

Silver Wyandotte Club of America. Carl H. Sommer, Rush City, Minn.

Texas Golden Wyandotte Club. Harry S. Fountaine, 1502 Hart Street, Georgetown, Tex.

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Orpingtons:

American Black Orpington Club. Ora Overholser, Odenton, Md.

American White Orpington Club. C. W. Walker, Manning, Iowa.

American Orpington Club. Ora Overholser, Odenton, Md.

Buff Orpington Club of Oklahoma. Lute Douge, Ada, Okla.

National Rose Comb Orpington Club. E. M. Mengel, Walbert Station, R. F. D. 3, Allentown, Pa.

National Single Comb Buff Orpington Club. Harold N. Bush, East Stroudsburg, Pa.

International Single Comb Buff Orpington Club. F. W. Englert, La Fayette, Ind.

Minorcas:

American Single Comb White Minorca Club. G. G. Truman, Perrysville, Ohio.

Buff Minorca Club. Edward F. Schmidt, Thorntown, Ind.

International Single Comb Black Minorca Club. Edwin M. Jewett, P. O. Box 1130, Tulsa, Okla.

Buff Minorca Club of America. William F. Williams, 1102 West Fifty-second Street, Los Angeles, Calif.

United White Minorca Club. Mrs. G. F. Barstow. Winona, Duluth, Minn.

Miscellaneous:

Blue Andalusian Club of America. Voris Morrison, Box A, Ramsey, Ill.

United Ancona Club. R. W. Van Hoesen, Franklinville, N. Y.

American Bantam Association. George Fitterer, P. O. Box 464, Chicago, Ill.

American Game Bantam Club. J. K. Brokaw, Somerville, N. J.

National Bantam Association. J. Hart Welch, Douglaston, N. Y.

American Light Brahma Club. Harvey C. Wood, 25 East Twenty-sixth Street, New York, N. Y.

American Buckeye Club. E. F. Trimble, Benton, Ky.

American Buttercup Club. R. J. La Lone, 49 Bay Street, Potsdam, N. Y.

American Cornish Club. Fred H. Bohrer, Utica, N. Y.

National American Dominique Club. A. W. Carter, Jefferson, Me.

American Guinea Club. Edward R. Flint, Flindell Farm, Tunbridge, Vt.

National Game Club. E. J. W. Dietz, 736 Cornelia Avenue, Chicago, Ill.

Jersey Black Giant Club. C. M. Page, Belmar, N. J.

American Houdan Club. Daniel P. Shove, Fall River, Mass.

Hamburg Fanciers' Club. Theodore L. Storer, 60 State Street, Boston, Mass.

American Java Association. Seth W. Morton, P. O. Box 587, Albany, N. Y.

National Black Langshan Club. William Buddenhagen, Brooklyn Station, R. R. 2, Cleveland, Ohio.

Miscellaneous—Continued.

American Polish Fowl Club. Hiram W. Schriver, Groton, Conn.

Waterfowl Club of America. Stanley Mason, Albrightsville, Pa.

Turkeys:

American Bronze Turkey Club. T. C. Amos, Russellville, Mo.

National Bronze Turkey Club. Charles E. Bird, Meyersdale, Pa.

National Bourbon Red Turkey Club. Mrs. Minnie M. B. Brown, Appleton City, Mo.

International Turkey Club. Mrs. Eli Fowler, Rochelle, Ill.

Associations:

American Poultry Association. Mrs. E. B. Rigg, 655 West Third Street, Fort Wayne, Ind.

International Baby Chick Association. Reese U. Hicks, Thirty-first and Main Streets, Kansas City, Mo.

National Pigeon Association. Harry A. Stone, 25 West Washington Street, Indianapolis, Ind.

American Incubator Manufacturers' Association. E. L. Coatsworth, P. O. Box 1636, Lincoln, Nebr.

EXHIBITION CLASSES

Chickens:

(1) Cock—male bird 1 year old and over.
(2) Cockerel—male bird under 1 year old.
(3) Hen—female bird 1 year old and over.
(4) Pullet—female bird under 1 year old.

Ducks:

(1) Adult drake—males 1 year old and over.
(2) Adult duck—females 1 year old and over.
(3) Young drake—males under 1 year old.
(4) Young duck—females under 1 year old.

Geese:

(1) Adult gander—males 1 year old and over.
(2) Adult goose—females 1 year old and over.
(3) Young gander—males under 1 year old.
(4) Young goose—females under 1 year old.

Turkeys:

(1) Adult cock—2 years old and over.
(2) Yearling cock—1 to 2 years old.
(3) Cockerel—males under 1 year old.
(4) Hens—female turkeys 1 year old and over.
(5) Pullets—female turkeys under 1 year old.

An exhibition pen consists of one male and four females of the same variety.

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PRODUCTION SCORE CARD FOR POULTRY

[Disqualifications: Decidedly crooked breasts, crooked backs, or wry tails]

Scale of points	Standard score
Health and vigor: The bird must be free from disease or any indication of having been affected with disease. It must also show strong constitution and great vigor, as indicated by bright-red comb and wattles, and by full, prominent, bright eyes, by general alertness, and by bright, lustrous plumage. Males should be decidedly masculine. Avoid females showing masculine appearance	15
Head (5 points):	
Shape of head: Should be short, deep, and broad	2
Face, comb, and wattles: Should be bright red. (Dark red approaching black indicates poor condition.) Wattles medium size. Comb small to medium, firmly set on head. Avoid lopped combs in those breeds where they are supposed to be upright	1
Eye: Large, full, bright. (Sunken or dull eye denotes lack of vigor and poor vitality)	1
Beak: Short, strong, curved	1
Neck: Medium short and stout in proportion to the body	3
Wings: Strong, medium size, neatly folded, and held firmly in place. (Avoid breeding from slipped or twisted winged birds)	5
Body (60 points).	
General shape: Body should show good length, breadth, and depth, and be well fleshed throughout.	
Breadth of body: Should be broad at shoulders, breadth extending downward well back to hips	5
Depth of body: Should be deep from shoulder to front of keel and extending well back	5
Back: Back of good length, broad throughout, and fairly level on top from side to side throughout its entire length, and ending in a broad, full tail	20
Breast: Deep, broad, full, corresponding with breadth of shoulders. Keel or breastbone should be long, straight, and well fleshed	30
Thinness and texture of skin: Skin should be thin and smooth, free from roughness or scaliness	2
Legs (10 points). Medium length and set well apart. (Knock-kneed individuals are undesirable.)	
Thighs and second joints: Short, thick, and heavily fleshed	6
Shanks: Short, strong	3
Toes: Strong, straight, short, well spread	1
Total	100

EXHIBITION SCORE CARD FOR BIRDS OF THE AMERICAN CLASS

Variety________________________ Weight________________

Entry No__________ Band No__________ Sex__________

(Name of association here)

(Date: Month, days, and year show is held, here)

Exhibitor ____

	Shape	Color	Total
Weight or size	--------	--------	4
Symmetry	--------	--------	4
Condition	--------	--------	4
Comb	--------	--------	6
Beak	2	2	4
Head	2	2	4
Eyes	2	2	4
Wattles	2	--------	2
Ear lobes	2	2	4
Neck	4	6	10
Wings	4	6	10
Back	5	5	10
Tail	5	5	10
Body and fluff	5	3	8
Breast	5	5	10
Legs and toes	3	3	6
Crest and beard	--------	--------	--------
	--------	--------	100

Total cuts____________________ Score__________

__________________________, *Judge.*

__________________________, *Secretary.*

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EXHIBITION SCORE CARD FOR BIRDS OF THE MEDITERRANEAN CLASS

Variety______________________ Weight________________

Entry No__________ Band No__________ Sex__________

(Name of association here)

(Date : Month, days, and year show is held, here)

Exhibitor ____

	Shape	Color	Total
Weight or size	--------	--------	4
Symmetry	--------	--------	4
Condition	--------	--------	4
Comb	--------	--------	6
Beak	2	2	4
Head	2	2	4
Eyes	2	2	4
Wattles	2	--------	2
Ear lobes	4	3	7
Neck	4	6	10
Wings	4	6	10
Back	5	5	10
Tail	6	4	10
Body and fluff	3	2	5
Breast	5	5	10
Legs and toes	4	2	6
Crest and beard	--------	--------	--------
	--------	--------	100

Total cuts____________________ Score____________

__________________________, *Judge.*

__________________________, *Secretary.*

EXHIBITION SCORE CARD FOR BIRDS OF THE ASIATIC CLASS

Variety__________________________ Weight______________

Entry No.___________ Band No.___________ Sex___________

(Name of association here)

(Date : Month, days, and year show is held, here)

Exhibitor ____

	Shape	Color	Total
Weight or size			4
Symmetry			4
Condition			4
Comb			6
Beak	2	2	4
Head	2	2	4
Eyes	2	2	4
Wattles	2		2
Ear lobes	2	2	4
Neck	4	6	10
Wings	4	6	10
Back	6	4	10
Tail	5	5	10
Body and fluff	5	3	8
Breast	6	4	10
Legs and toes	3	3	6
Crest and beard			
			100

Total cuts________________ Score__________

________________________, *Judge.*

________________________, *Secretary.*

INCUBATION PERIOD OF VARIOUS BIRDS

	Days		Days
Chicken	21	Guinea fowl	28
Duck	28	Pigeon	17
Goose	30	Turkey	28

Feeding

Mineral Requirements.—Grit is essential to the health of fowls, and also to economy in feeding. A box of grit should be kept in every pen or yard. Laying hens should be supplied crushed oyster shells, clam shells, old mortar, or other sources of lime for the shells of eggs.

Rations

Breeding Stock.—(1) Feed the breeding stock a variety of grain which will keep them in the best possible breeding condition.

(2) Many poultrymen use as breeders yearling hens which have been selected from the best-laying pullets of the previous year.

(3) These yearling hens should be given a rest at the end of their first laying year.

(4) During the winter months prior to the breeding season feed a scratch ration composed of the following parts by weight:

Two parts yellow corn.
One part wheat.
One part heavy oats.

Feed the scratch mixture in a litter 5 or 6 inches deep.

(5) A good dry-mash mixture for breeding stock is made up of the following parts by weight:

Two parts corn meal.
One part bran.
One part crushed oats.
One part middlings.

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One-half part beef scraps.
One-fourth part bone meal.
One-fourth part ground limestone.

(6) Feed the breeding stock liberally of skim milk or buttermilk.

(7) The breeding stock should get green feed every day, such as sprouted oats, kale, cabbage, or well-cured alfalfa or clover hay.

(8) Clean water should always be available.

(9) Grit or oyster shell should be before the birds all the time.

Fattening Stock.—(1) Confine the market birds in pens or fattening crates.

(2) Fatten for 10 days to 3 weeks, depending upon the size, the smaller-sized birds requiring the longest fattening.

(3) Feed very lightly the first few days or the birds will lose appetite and not fatten properly.

(4) A good fattening ration is composed of the following by weight:

Two parts corn meal.
One part rolled oats.
One part middlings.

Always use skim milk to moisten the mash mixture, and use enough milk to make the mixture run freely when it is poured from the pail into the trough.

(5) Do not allow uneaten feed to remain before the birds for any length of time.

Growing Chicks.—(1) Do not feed the chicks before they are about 72 hours old.

(2) For the first five or six weeks feed little at a time but frequently—at least five times daily.

(3) From the beginning give all the sour milk they will drink.

(4) For about the first week they can be fed the following:

Two parts corn meal.
Two parts rolled oats.
One part boiled egg.

Or—

Two parts rolled oats (by weight).
Two parts corn meal.
One part bran.
One part middlings.

After the first week they can be fed the following mixtures:

Scratch grain, equal parts by weight—
Finely cracked yellow corn.
Finely cracked wheat.

And a dry-mash mixture of—
Four parts corn meal (by weight).
Two parts bran.
Two parts rolled oats.
One part middlings.
One part beef scrap of good quality.

This method of feeding can be continued for five or six weeks, and then a less expensive mash mixture can be fed.

(5) Give plenty of green feed at all times, such as lettuce, chopped cabbage, leaves, lawn clippings, or sprouted oats.

(6) Provide hoppers of fine grit and fine oyster shell.

(7) Clean water should never be wanting.

(8) Clean and disinfect the feeding utensils regularly.

Laying Stock.—(1) Feed regularly on a variety of wholesome grains, and feed so that the layers will take plenty of exercise.

(2) In the winter, both morning and evening, feed a scratch ration composed of the following by weight:

Two parts yellow corn.
One part wheat.
One part heavy oats.

In the summer use equal parts of the three grains. Feed the scratch mixture in litter 5 or 6 inches deep.

(3) A good dry-mash mixture is composed of the following parts by weight:

Two parts corn meal.
One part bran.
One part crushed oats.
One part middlings.
One part beef scraps.

Keep this mash in self-feeding troughs, so that the birds can help themselves at any time. If the morning feeding of scratch grain is rather light the birds will consume more mash, and this stimulates egg production.

(4) Provide the layers with plenty of green feed every day. Sprouted oats, kale, cabbage, mangels, well-cured alfalfa, or clover hay all provide succulence, and some provide vitamins.

(5) Give the layers all the skim milk they will drink.

(6) Clean water should always be available.

(7) Grit and oyster shell should be before the birds at all times.

Water.—Plenty of fresh water should always be accessible to poultry. It should not be exposed to sun in the summer nor allowed to freeze in the winter. A flock of 50 hens in laying condition will require from 4 to 6 quarts of water a day, supplied preferably in several containers.

Management

Brooding.—(1) When brooding with hens provide good coops for protection from rains, and do not allow the hen and chicks to roam in long grass until the chicks are three to four weeks old.

(2) For brooding artificially coal-burning stoves are best.

(3) Not more than 250 chicks should be brooded under one stove.

(4) Keep the temperature under the hover about 4 inches off the floor 100° F. for the first week, and drop it from 3° to 5° each subsequent week, depending upon the season of the year. When the temperature is right the chicks will spread out in a circle around the edge of the hover.

(5) Do not allow the chicks to become chilled, as this usually makes them crowd and may cause diarrhea and much loss.

(6) Always brood on soil that is well drained and free from contamination.

(7) Get the chicks out on the ground as soon as possible, but keep them confined in a wire inclosure for the first few weeks.

(8) Clean and disinfect the brooder house regularly.

(9) Provide plenty of shade.

(10) Rear the chicks away from the old stock.

Culling.—(1) Constantly cull the laying stock, to remove unhealthy birds.

(2) Cull the whole flock thoroughly some time during the late summer or early fall. Use the following table as the basis for culling, except that the pigmentation factors will not apply to Orpingtons and other breeds with noncolored shanks, and the ear-lobe factor applies only to Leghorns and similar breeds.

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Culling table

Body parts	Good layer	Poor layer
Beak	White	Yellow.
Shanks	do	Do.
Eye ring	do	Do.
Ear lobe	do	Do.
Head	Lean	Flat.
Eye	Bright, bulging	Dull, flat.
Comb	Large, plump, bright	Small, shrunken, dull.
Body	Wide, full	Narrow, shallow.
Skin	Thin, pliable	Thick, coarse.
Pelvic span	Wide, thin	Narrow, thick.
Vent	White, large, moist	Yellow, small, dry.
Molting	Late, slow	Early, fast.

Equipment—*Self-feeder.*—Self-feeders save labor in feeding poultry and furnish a good method for feeding dry mash, grit, and oyster shells. An open, square box about 8 inches deep makes the best mash hopper. This should have a wire screen of 2-inch mesh as a follower laid on top of the mash.

Incubation.—(1) Select eggs of good hatching quality from breeding stock that is healthy, vigorous, and fully matured.

(2) For high fertility, mate the breeders at least two weeks before eggs are to be saved. Collect eggs at least twice daily; do not allow them to become chilled.

(3) Use fresh eggs only. Do not hold them more than 10 days; the fresher the better. Keep them at a temperature of about 50° F.

(4) Handle the eggs carefully. Do not wash them.

(5) Hatch early. Early hatched pullets make good winter layers. In the South chicks should not be hatched after the middle of April; in the North Leghorns should not be hatched after the middle of May, and other breeds after the 1st of May.

(6) Where incubating under hens, make the nests on the ground or in boxes 14 inches square by 12 inches deep with sod in the bottom. Dust the hens with lice powder two or three times during the setting. In cold weather give each hen about 13 eggs and in warm weather about 15. Feed and water the hens every day and see that they go back to the nests.

(7) Where incubators are used, a well-made machine should be selected. The larger the machine the lower the cost of incubation per egg. Be sure the incubator is level. Place it in a room where the temperature is fairly constant throughout the hatching season. Clean and thoroughly disinfect the incubator before each hatch. Be sure the thermostat works well and is properly adjusted. Start the machine two or three days before placing eggs in it. Use only good oil, and trim the wick carefully each day. The temperature on a level with the top of the eggs should be 101° F. for the first week, 102° for the second, and 103° for the third. Turn the eggs at least twice daily. Place a moisture pan in the bottom of the egg chamber, or sprinkle the eggs every day with lukewarm water. Test the eggs on the seventh and fourteenth days. Leave the chicks in the incubator for about a day after the first ones hatch.

REGULATORY WORK

28-Hour Law

Feeding, Watering, and Resting of Livestock.—In order to avoid the difficulties experienced by transportation companies, shippers, and others in computing the quantities of feed which should be given to animals while in the course of interstate transportation, the Bureau of Animal Industry, in connection with the enforcement of the 28-hour law (34 Stat. 607), has given consideration to the feeding, watering and resting of cattle, sheep, hogs, and other animals, and has determined that the use of a carload as a unit basis, rather than the hundredweight of animal, is a more satisfactory method for arriving at the quantity of feed which should be given to the animals.

As a result, the conclusion has been reached that the handling of animals in accordance with the suggestions outlined below will meet the views of the Department of Agriculture as to the minimum requirements of the law:

Horses and mules, not less than 200 pounds of hay or its equivalent per car.

Cattle, not less than 200 pounds of hay or its equivalent per car.

Sheep or goats, not less than 100 pounds of hay or its equivalent per deck.

Swine, not less than 2 bushels of shelled corn or its equivalent in ear corn or other grain per single-deck car of not more than 17,000 pounds weight; not less than 2½ bushels of shelled corn or its equivalent in ear corn or other grain per double-deck car of not more than 21,000 pounds weight.

Carload lots of hogs in excess of these weights should be fed an additional quantity in the same proportion.

Animals shipped in lots less than a carload should be fed a pro rata quantity based on the above figures.

Calves too young to eat hay or grain and shipped alone should be given a sufficient quantity of some suitable food, such as milk or raw eggs.

The rations above indicated are to be given each time the animals are fed to comply with the provisions of the law.

Unloading.—The only practicable methods for railroads to transport animals other than hogs without unloading during each period prescribed by the statute for rest, water, and feeding are in "palace" or similar stock cars and with emigrant outfits. There are cases in which exceptional facilities complying with the law make unloading unnecessary; for instance, specially equipped cars conveying show animals and blooded stock. In such cases care should be taken to observe the law. In all cases, if animals are not unloaded, sufficient space to permit all the animals to lie down in the cars at the same time must be provided.

Hogs may be fed, watered, and rested without being unloaded, provided (1) the cars are loaded so as to allow all the animals to have sufficient space to lie down at the same time, (2) the trains are stopped for sufficient time to allow the watering troughs to be prepared and to allow every hog time to drink his fill, and (3) care is exercised to distribute properly through each car deck sufficient shelled corn or its equivalent in ear corn or other grain for each hog.

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Unloading Pens.—All pens into which animals are unloaded must contain adequate facilities for feeding and watering, and suitable space on which the animals can lie down comfortably for resting. Covered pens should be provided for unloading animals in severe weather.

Certification of Health: Regulations Governing the Interstate Movement of Livestock (B. A. I. Order 273)

Definition of Stockyards—*Regulation 1, section 1, paragraph 9: Public stockyards.*—Stockyards where trading in livestock is carried on; where yarding, feeding, and watering facilities are provided by the stockyards, transportation, or similar company, and where Federal inspection is maintained for the inspection of livestock for communicable diseases.

Cattle.—*Regulation 3, section 7: Shipments from public stockyards.*—No cattle shall be shipped or moved interstate from any public stockyards where an inspector of the Bureau of Animal Industry is stationed for the inspection of livestock for communicable diseases without a certificate issued by the said inspector showing that the cattle are free from contagious disease or have been properly dipped: *Provided,* That this restriction shall not apply to shipments of cattle unloaded in transit for feed, water, and rest, and not offered for sale. If diseased cattle are introduced into the noninfectious yards or portions thereof, the chutes, alleys, and pens used by them shall be thoroughly cleaned and disinfected.

Regulation 7, section 1, paragraph 1: To prevent the spread of tuberculosis in cattle.—No cattle shall be shipped, driven on foot, transported, or received for transportation interstate unless and until such cattle have been subjected to a physical examination and tuberculin test, and a tuberculin-test chart and health certificate, showing them to be apparently free from tuberculosis and any other contagious, infectious, or communicable disease of animals, has been issued.

Section 2.—Cattle of the following classes may be shipped, driven on foot, transported, and received for transportation interstate without the provisions of section 1 of this regulation being complied with, provided the following conditions and requirements are strictly complied with, to wit:

Paragraph 1: Accredited herds.—Cattle from a herd accredited by the Bureau of Animal Industry, in cooperation with the various States, as free from tuberculosis shall be accompanied by a certificate issued by an authorized State or Federal inspector showing the cattle to be from such a herd.

Paragraph 2: Steers and range cattle.—Steers and strictly range cattle may be shipped, transported, or otherwise moved interstate to a State or Territory, the laws, rules, or regulations of which do not require these classes of cattle to be tuberculin tested.

Paragraph 3: Slaughter cattle.—Cattle for immediate slaughter shall be shipped, transported, or otherwise moved to a place where bureau or State meat-inspection service is maintained, or to a place designated by the proper State livestock sanitary official of the State of destination.

Paragraph 4: Shipments to public stockyards.—Cattle free from any infectious, contagious, and communicable disease may be shipped, transported, or otherwise moved interstate to a public stockyard without restriction.

Paragraph 5: Feeding and grazing cattle.—Female cattle for feeding or grazing purposes, and bulls for feeding purposes may be shipped, transported, or otherwise moved interstate from public stockyards upon permission being first obtained from the bureau inspector at said stockyards. Such cattle shall be shipped, transported, or otherwise moved only to a State, the laws or regulations of which provide for the quarantine of such cattle through the feeding or grazing period, and for their release only on written permit by the proper State regulatory authorities.

Sheep.—*Regulation 4, section 6, paragraph 2: Shipments from public stockyards.*—No sheep shall be shipped or moved interstate from any public stockyards where a bureau inspector is stationed for the inspection of livestock for communicable diseases without a certificate issued by such inspector showing that the sheep are free from contagious disease or have been properly dipped: *Provided,* That this restriction shall not apply to shipments of sheep unloaded in transit for feed, water, and rest, and not offered for sale.

Hogs—*Regulation 6, section 2, paragraph 2: Movements from public stockyards.*—Hogs may be shipped, transported, or otherwise moved interstate from public stockyards for purposes other than slaughter to States the laws, rules, or regulations of which provide for the segregation or quarantine of imported hogs for a period of not less than three weeks: *Provided,* That the following requirements are strictly observed and complied with:

(*h*) The shipment shall be accompanied by a certificate issued by a bureau inspector.

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7. DAIRYING

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DAIRYING

DAIRY FARMING

Quantities of milk, butter, and cheese produced on farms during 1919, and number of dairy cows and yield of milk per cow

[Bureau of the Census]

State	Milk produced on farms	Farm butter	Farm cheese	Dairy cows	Yield per cow
	Gallons	*Pounds*	*Pounds*	*Number*	*Lbs.*
Alabama	93,903,677	28,490,181	5,210	394,112	1,944
Arizona	14,370,833	593,446	90,119	31,619	3,724
Arkansas	87,623,651	25,571,098	8,603	415,507	1,634
California	276,424,216	5,757,759	2,345,672	502,415	4,610
Colorado	79,492,631	5,775,602	157,186	192,234	2,993
Connecticut	54,894,287	1,926,127	90,500	112,622	4,128
Delaware	11,356,313	894,883	3,170	33,026	2,924
District of Columbia	512,074	6,026	---------	704	6,218
Florida	12,155,533	1,162,383	3,156	71,641	1,307
Georgia	101,615,773	30,257,153	1,365	388,448	2,124
Idaho	52,365,498	4,540,364	31,684	115,336	3,560
Illinois	370,486,981	25,063,897	117,830	957,313	3,044
Indiana	238,793,861	18,344,239	109,234	608,211	3,044
Iowa	361,426,362	25,422,675	53,273	897,668	2,709
Kansas	221,454,417	17,455,879	19,657	574,257	3,311
Kentucky	146,561,464	34,080,415	13,643	441,346	2,666
Louisiana	32,972,720	4,252,318	5,972	176,936	1,324
Maine	77,676,881	10,855,560	55,161	175,425	3,724
Maryland	58,754,193	6,162,501	126,190	161,972	3,036
Massachusetts	76,316,309	2,019,231	60,796	147,331	4,352
Michigan	382,822,631	25,755,423	76,660	802,095	3,965
Minnesota	475,506,689	20,205,076	71,820	1,229,179	3,044
Mississippi	88,191,682	20,758,736	2,783	427,406	1,591
Missouri	228,907,721	29,470,763	90,435	661,959	2,339
Montana	51,251,095	5,961,336	43,223	127,581	2,864
Nebraska	168,083,367	13,761,085	23,117	438,459	2,528
Nevada	6,312,105	266,027	22,927	13,349	3,854
New Hampshire	42,556,285	3,240,368	32,469	95,997	3,689
New Jersey	70,490,729	1,600,789	92,984	130,497	4,575
New Mexico	12,737,649	1,404,138	87,087	37,805	2,210
New York	756,045,942	24,727,662	521,445	1,481,918	4,317
North Carolina	95,747,638	25,551,506	16,168	290,223	2,666
North Dakota	138,606,540	14,413,180	50,065	370,707	2,657
Ohio	396,317,787	30,264,265	434,042	888,057	3,603
Oklahoma	135,820,769	22,214,546	11,116	456,332	2,012
Oregon	92,844,946	4,177,628	43,898	180,462	4,136
Pennsylvania	421,631,355	38,468,607	532,238	885,855	3,990
Rhode Island	12,099,111	174,902	10,410	21,431	4,730
South Carolina	52,954,637	13,846,353	171	187,846	2,348
South Dakota	124,427,638	10,267,171	10,591	336,892	2,339
Tennessee	130,285,934	37,166,063	114,386	415,128	2,494
Texas	202,974,353	49,405,152	107,683	833,586	1,840

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Quantities of milk, butter, and cheese produced on farms during 1919, and number of dairy cows and yield of milk per cow—Continued

State	Milk produced on farms	Farm butter	Farm cheese	Dairy cows	Yield per cow
	Gallons	*Pounds*	*Pounds*	*Number*	*Lbs.*
Utah	29,339,512	2,876,675	73,606	66,724	3,466
Vermont	122,095,734	3,877,039	75,502	290,122	3,560
Virginia	110,942,113	25,476,621	39,765	357,969	2,511
Washington	140,524,518	5,899,678	84,868	238,270	4,911
West Virginia	73,690,103	17,715,107	88,562	181,206	2,984
Wisconsin	858,258,521	8,666,037	308,117	1,795,122	4,016
Wyoming	14,613,581	1,422,822	6,837	34,997	2,692
Total	7,805,238,069	707,666,492	6,371,396	19,675,297	[1] 3,148

[1] Weighted average of entire United States.

Dairy Cattle

The champion butterfat and milk producers among the various breeds of dairy cattle in the United States, July 1, 1926, were as follows:

Leading butterfat producers

Breed	Cow	Milk	Butterfat
		Pounds	*Pounds*
Ayrshire	Betsy Wylie	21,805	1,103.00
Brown Swiss	June's College Girl, 11427	24,572	1,062.30
Dutch Belted	Angelina 2641	16,023	668.07
Guernsey	Anesthesia Faith of Hill Stead 114354.	19,742	1,112.00
Holstein	De Kol Plus Segis Dixie 295135.[1]	33,465	1,349.31
Jersey	Darling's Jolly Lassie 435948	16,425	1,141.28

[1] Canadian cow.

Leading milk producers

Breed	Cow	Milk	Butter-fat
		Pounds	*Pounds*
Aryshire	Garclaugh May Mischief 27944	25,329.0	894.91
Brown Swiss	Believe 4245	25,847.8	1,002.62
Dutch Belted	Gem of Columbia 2038	17,268.2	633.82
Guernsey	Murne Cowan 19597	24,008.0	1,098.00
Holstein	Segis Pietertje Prospect 221846	37,381.4	1,158.95
Jersey	Madeline of Hillside 389336	20,624.0	1,044.05

Some facts about the dairy breeds

Ayrshire.—Originated in southwestern Scotland.
First importation, 1822.
Number in United States: Purebred, 30,000; grade, 400,000.
Color: White and red or brown, either color predominating.
Weight: Calves at birth, 60 to 80 pounds.
Mature cows, 850 to 1,250 pounds.
Mature bulls, 1,500 to 2,000 pounds.
Cows with official yearly records, up to January 1, 1925, 6,368.
Average production: Milk, 10,256 pounds.
Butterfat, 407.48 pounds.
Test, 3.97 per cent.

Brown Swiss.—Originated in Switzerland.
First importation, 1869, to Massachusetts.
Number in United States: Purebred, 8,000; grade, 162,000.
Color: Dark to light brown, sometimes gray, stripe of gray along back.
Weight: Calves at birth, 65 to 90 pounds.
Mature cows, 1,100 to 1,500 pounds.
Mature bulls, 1,500 to 2,200 pounds.
Cows with official yearly records, up to January 1, 1926, 476.
Average production: Milk, 12,534 pounds.
Butterfat, 501.60 pounds.
Test, 4.00 per cent.

Dutch Belted.—Originated in Holland.
First importation, probably 1838.
Number in United States: Purebred, 6,000; grade, 150,000.
Color: Black, with broad white belt around middle.
Weight: Calves at birth, 60 to 90 pounds.
Mature cows, 1,000 to 1,500 pounds.
Mature bulls, 1,500 to 2,000 pounds.
Average production of cows with official yearly records, up to January 1, 1926: Milk, 10,141 pounds.
Butterfat, 384.64 pounds.
Test, 3.80 per cent.

Guernsey.—Originated in Channel Islands.
First importation of registered Guernseys, 1830.
Number in United States: Purebred, 80,000; grade, 1,900,000.
Color: Fawn and white, with fawn predominating; sometimes red and white.

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Weight: Calves at birth, 55 to 85 pounds.
Mature cows, 800 to 1,400 pounds.
Mature bulls, 1,200 to 2,200 pounds.
Cows with official yearly records, up to January 1, 1926, 20,931.
Average production: Milk, 9,615 pounds.
Butterfat, 480.1 pounds.
Test, 4.99 per cent.

Holstein-Friesian.—Originated in northern Holland and northwestern Germany.
Formerly two associations in United States, Holstein and Dutch Friesian; combined in 1885 under present name.
First importation, 1795.
Number in United States: Purebred, 528,000; grade, 10,500,000.
Color: Black and white, not blended, but sharply defined.
Largest of dairy breeds.
Weight: Calves at birth, 70 to 105 pounds.
Mature cows, 1,100 to 1,750 pounds.
Mature bulls, 1,600 to 2,200 pounds.
Cows with official yearly records, up to January 1, 1926, 23,622.
Average production: Milk, 15,697 pounds.
Butterfat, 532.44 pounds.
Test, 3.39 per cent.

Jersey.—Originated in the Channel Island of Jersey.
First importation of Jerseys under that name, 1850.
Number in United States: Purebred, 232,000; grade, 9,300,000.
Color: Some shade of fawn, brown, or cream color, solid or spotted with white.
Smallest of the leading dairy breeds.
Weight: Calves at birth, 40 to 75 pounds.
Mature cows, 700 to 1,200 pounds.
Mature bulls, 1,200 to 1,800 pounds.
Cows with official yearly records, up to January 1, 1925, 22,355.
Average production: Milk, 8,287 pounds.
Butterfat, 444.37 pounds.
Test, 5.36 per cent.

Bull Associations.—A cooperative bull association is an organization of farmers formed for the purpose of joint ownership, use, and exchange of three or more high-class purebred bulls. The purchase price and cost of maintenance of the bulls are distributed according to the number of herds or the number of cows owned by the members. The organization tends to establish in a community one breed of cattle and a systematic means of continuous dairy-herd improvement by making the maximum use of prepotent sires.

Breeders' Associations.—The interests of the different breeds of dairy cattle are in charge of organizations of breeders, which determine purity of breeding, verify pedigrees, register eligible animals, and publish herdbooks. Some of these associations record and publish sales and transfers and attested records of dairy performance; they also establish standards of excellence and carry on general breed-promotion work. The details of the work are usually left to the secretary. The names of the various associations and the addresses of the secretaries are as follows:

American Guernsey Cattle Club. Secretary, Karl B. Musser, Peterboro, N. H.

American Jersey Cattle Club. Secretary, L. W. Morley, 324 West Twenty-third Street, New York, N. Y.

Ayrshire Breeders' Association. Secretary, C. T. Conklin, Brandon, Vt.
Brown Swiss Cattle Breeders' Association. Secretary, Ira Inman, Beloit, Wis.
Dutch Belted Cattle Association of America. Secretary, R. J. Leonard, Rockville, Conn.
Holstein-Friesian Association of America. Secretary, F. L. Houghton, Brattleboro, Vt.

In addition to the dairy cattle named above, some breeds, primarily developed for beef production, are occasionally bred and used as dairy cattle. Their associations are as follows:

American Devon Cattle Club. Secretary, Richard Pattee, 51 Cornhill, Boston, Mass.
American Shorthorn Breeders' Association. Secretary, P. K. Groves, 13 Dexter Park Avenue, Stockyards, Chicago, Ill.
Milking Shorthorn Society. Secretary, Roy A. Cook, Independence, Iowa.
Red Polled Cattle Club of America. Secretary, H. A. Martin, Richland Center, Wis.

Official Testing.—The following tables give the requirements for admission to official record of production of dairy breeds:

Ayrshire

ADVANCED REGISTRY, SINGLE LETTER. TIME, 365 DAYS, IN ONE LACTATION

Class G, lowest age, 2 to 2½ years	Classes F to B, intermediate ages, half-year divisions (class F, 2½ to 3 years, etc.)	Class A, highest age, 5 years and over	Calving
2 years and under	2 to 5 years	5 years and over	
336 pounds butterfat.	4 pounds additional butterfat for each additional month of age.	480 pounds butterfat.	
8,400 pounds milk.	100 pounds additional milk for each additional month of age.	12,000 pounds milk.	

ROLL OF HONOR, DOUBLE LETTER. TIME, 305 DAYS, IN ONE LACTATION

Class GG, lowest age, 2 to 2½ years	Classes FF to BB, intermediate ages, half-year divisions	Class AA, highest age, 5 years and over	Calving
2 years and under	2 to 5 years	5 years and over	
256 pounds butterfat.	4 pounds butterfat for each additional month.	400 pounds butterfat.	Calve in 400 days after first day of test.
6,400 pounds milk.	100 pounds milk for each additional month.	10,000 pounds milk.	

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Herd test rules for Ayrshire breed.—Every cow in the herd must be tested.

The test is for one year.

Cows are limited to twice-a-day milking except when daily production exceeds 40 pounds in mature cows, varying to 25 pounds in 2-year-old heifers.

Individual certificates will be issued to cows producing in one year as follows:

2 years and under	2 to 5 years	5 years and over	Calving
192 pounds butterfat. 4,800 pounds milk.	3 pounds butterfat for each additional month. 75 pounds milk for each additional month.	300 pounds butterfat. 7,500 pounds milk.	Calve within 400 days of the previous freshening.

Brown Swiss

FULL-YEAR TEST, 365 DAYS, ONE OR MORE LACTATIONS

Lowest age,* 2½ years and under	Intermediate ages	Highest age, 5½ years and over	Calving
250.5 pounds butterfat.	0.1 pound additional butterfat for each additional day of age.	360 pounds butterfat.	

TEN-MONTHS' TEST, 305 DAYS, ONE LACTATION

220.5 pounds.	0.1 pound for each additional day.	330 pounds.	Calve in 14 months from previous calving.

FARMERS' CLASS, TIME 305 DAYS, ONE LACTATION

Same as 10-months' test above, except that cow must be milked only three times a day for first 15 days, and after that only twice a day.

Dutch Belted

GROUP DESIGNATED BY SINGLE LETTER. TIME, 365 DAYS

Class G, lowest age, 2 to 2½ years	Classes F to B, intermediate ages, half-year divisions (class F, 2½ to 3 years, etc.)	Class A, highest age, 5 years and over	Calving
2 years and under	2 to 5 years	5 years and over	
250.5 pounds butterfat. 6,000 pounds milk.	0.1 pound additional butterfat for each additional day of age. 500 pounds more milk for each additional 6 months of age.	360 pounds butterfat. 9,000 pounds milk.	

ROLL OF HONOR, DESIGNATED BY DOUBLE LETTER. TIME, 300 DAYS

Class GG	Classes FF to BB	Class AA	Calving
Same production requirements as for single-letter classes.			Must carry calf 180 days of test.

Guernsey

GROUPS DESIGNATED BY SINGLE LETTER. TIME, 365 DAYS

Class G, lowest age, under 2½ years	Classes F to B, intermediate ages, half-year divisions (class F, 2½ to 3 years, etc.)	Class A, highest age, 5 years and over	Calving
2 years or under, 290.5 pounds butterfat.	2 to 5 years, 0.1 pound additional butterfat for each additional day of age.	5 years and over, 400 pounds butterfat.	

GROUPS DESIGNATED BY DOUBLE LETTER. TIME, 365 DAYS

Class GG	Classes FF to BB	Class AA	Calving
Requirements same as for single-letter classes, except calving.			Must carry calf 265 days of test.

FARMERS' CLASS. TIME, 305 DAYS, BEGINNING IN 30 DAYS FROM FRESHENING, AND FINISHED IN ONE LACTATION PERIOD; COW MILKED NOT MORE THAN TWICE A DAY

250.5 pounds butterfat.	0.1 pound for each additional day.	360 pounds butterfat.	Must carry calf 205 days of test.

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Holstein

A. R. S. O.

FULL YEAR

Lowest age, 2 years old or under	Intermediate ages	Highest age, 5 years or older	Calving
318 pounds butterfat.	0.1479 pounds additional butterfat for each additional day of age.	480 pounds butterfat.	

TEN MONTHS

85 per cent of full year requirement (270.3 lbs.).	85 per cent of full year requirement (0.125715 pound for each additional day).	85 per cent of full year requirement (408 lbs.).	Calve in 14 months from previous calving.

Subdivision A of the above tests includes all cows milked four times a day after the first 45 days of the test.

Subdivision B includes cows milked three times a day after the first 45 days.

Subdivision C includes cows milked twice a day after first 45 days.

CERTIFICATE OF MERIT

FULL YEAR

250.5 pounds butterfat.	0.1 pound additional butterfat for each additional day of age.	360 pounds butterfat.	

TEN MONTHS (305 DAYS)

220.5 pounds butterfat.	0.1 pound for each additional day.	330 pounds butterfat.	Calve in 14 months.

Jersey

CLASS A

Lowest age, 2 years and under	Intermediate ages	Highest age, 5 years and over	Calving
Full-year test, same production requirements as class AA.			No requirements as to calving.
10-months' test, same production requirements as class AA.			Do.

CLASS AA

FULL YEAR, 306 TO 365 DAYS

290.5 pounds butterfat.	0.1 pound additional butterfat for each additional day of age.	400 pounds butterfat.	Calve in 16 months from previous calving.

TEN-MONTHS' TEST, NOT EXCEEDING 305 DAYS

250.5 pounds butterfat.	0.1 pound for each additional day.	360 pounds butterfat.	Calve in 16 months.

CLASS AAA

10-months' test only, same production requirements as class AA.	Calve in 14 months.

Keeping Individual Production Records.—The principal reason for keeping milk-production records is to show which cows are profitable and which are not. Production records also furnish information that is used as a basis for feeding. Cows should be fed according to the quantity of milk or butterfat produced. Sickness and other abnormal conditions are generally accompanied or preceded by a decline in milk production. This decline can easily be noted if the practice of weighing and recording the milk daily is followed. A spring-balance scale is necessary. These scales are equipped with adjustable hands so that the quantity of milk can be read without subtracting the weight of the bucket. A sheet for recording the daily weight should be placed in a clean and light place near the scales. Both scales and milk sheets can be obtained from dairy-supply houses. Many publishers of dairy periodicals also distribute milk sheets for a nominal price.

At regular intervals samples of milk from individual animals should be tested for butterfat. A common practice is to take a composite sample of milk from each cow for two or three consecutive days about the middle of the month. The butterfat percentage obtained from this test is used as the average for the month, and the total butterfat production is computed from this percentage. In many sections cow-testing associations are in operation for doing the testing and for keeping records.

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Cow-Testing Associations—*Definition.*—A cow-testing association is an organization of about 26 dairy farmers who cooperatively employ a man to test their cows for economical production of milk and butterfat.

Organization.—The need is determined before any attempt is made to organize. A meeting is then called and a temporary organization effected. The neighborhood is thoroughly canvassed until about 26 dairy farmers have agreed to become members. Copies of constitution and by-laws and of the cow-tester's contract may be obtained from the Bureau of Dairy Industry, United States Department of Agriculture. A permanent organization is effected. Officers are elected as provided for in the constitution and by-laws. A tester is then hired and the work begun.

Duties of the tester.—He visits each farm one day each month and from that day's feed and production records determines the monthly records of each cow in the herd.

Cost.—Salaries of testers range usually from $75 to $100 per month. In addition the association furnishes the needed equipment and the farmers provide board and transportation. Blank forms and record books are furnished by the Bureau of Dairy Industry, through the State specialist in charge of cow-testing associations in each State, with the understanding that copies of individual cow records will be furnished to the bureau in return.

Expected results.—Selection, feeding, and breeding, based on cow-testing association records, may increase production from 50 to 100 per cent.

Calves and Young Stock.—Strong, healthy calves are more likely to be dropped by well-nourished cows. The best time to wean the calf is after it has taken the first milk. Early weaning makes it easier to teach the calf to drink.

Everything about the calf should be scrupulously clean.

Milk from infected cows or from a creamery should be Pasteurized before it is fed.

Calves should be fed sweet milk of a uniform temperature and should always receive a little less than they desire.

All calves should be fed regularly; very young calves should be fed three times a day.

At first the calf is fed whole milk, the quantity being gradually increased. Skim milk is substituted as soon as practicable and, if cheap, is continued until the calf is 6 months old. Ordinarily the maximum quantity of skim milk that can be fed economically is 20 pounds a day. When the calf is 2 weeks old grain and bright, clean hay should be offered; the quantity fed should be increased as the calf's appetite demands.

Milk substitutes are not equal to milk but give fair results when used with care.

Quarters must be clean and dry, with plenty of bedding.

Stanchions save milk, make feeding easier, and prevent the calves from sucking each other.

Horns are more easily removed by use of caustic potash when the calf is young than later.

Young calves need water as well as milk.

Marks for identification should be plain without disfiguring the animal.

Calf diseases are largely the result of filth and carelessness. Prevention is cheapest and best.

Young dairy stock should have all the hay they will eat, and grain in proportion to weight.

The heifer should be bred to freshen at from 2 to 2½ years of age. Handling before freshening prevents shyness.

Fall calving usually gives best results.

The young bull should have an abundance of feed, plenty of exercise, and not too heavy service.

Calf meals.—On dairy farms where the milk is sold as whole milk at high prices there is a strong demand for feeds to take the place of the milk fed to the calves. The time at which calves can be put on milk substitutes depends upon the breed, development, and vigor of the calves. It is hardly safe, as a rule, even with the most vigorous ones, to attempt to put them on milk substitutes alone within three weeks after birth; and if calves are below normal in vigor, some milk for six weeks or more may be necessary to raise them. When a substitute for milk is supplied an attempt is usually made to use a liquid which in composition closely resembles milk.

Beltsville calf meal.—The following mixture has been devised as the result of experience at the experimental farm of the Bureau of Dairy Industry at Beltsville, Md.:

Take 50 parts finely ground corn; 15 parts linseed-oil meal; 15 parts finely ground rolled oats; 10 parts dried-blood flour; 10 parts skim-milk powder; one-half part salt. Mix with warm water at the rate of 1 pound of meal to 9 pounds of water. Increase gradually the quantity fed as whole milk is decreased, until at the time the calf is about 50 days old it should be getting only the gruel. At this time 1½ to 2 pounds of the meal mixed with water will constitute a day's feed.

In the feeding of all-milk substitutes the quantity fed should be substantially the same as when separated or whole milk is fed. If, however, there are indications of scours, the quantity should be reduced. The following may serve as a guide in using milk substitutes for feeding strong, vigorous calves:

First week	Whole milk.
Second week	Whole milk.
Third week	3 parts whole milk, 1 part gruel.
Fourth week	Do.
Fifth week	Whole milk and gruel, equal parts.
Sixth week	Whole milk, 1 part; gruel, 3 parts.
Seventh week	All gruel.

The same quantity of grain and roughage should be fed with milk substitutes as with separated milk.

Cows (Dairy-Cattle Management).—*Length of dry period.*—This depends on the quantity of milk a cow has produced and her condition as regards flesh. Cows of low or medium production do not require so long a dry period as high producers. Cows should be dry a month or six weeks if in good flesh. Thin cows should be dry longer. High producers may require two months or more.

Drying off.—Most cows can be dried off by the gradual lessening of the frequency of milking; that is, first skip one regular milking, then skip two, then three, etc. When the daily production is only 6 or 8 pounds, milking may be stopped entirely. With persistent producers it is often necessary to reduce the allowance of feed, especially grain, and give dry roughage.

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Season of year for freshening.—The Bureau of Dairy Industry has compiled some figures in regard to the most profitable season for cows to freshen. The conclusions are based on a study of 10,870 yearly records in 64 cow-testing associations, and are summarized as follows:

Figures showing most profitable season for cows to freshen

Season of freshening	Number of cows	Milk production	Butterfat production	Cost of roughage	Cost of grain	Cost of feed	Income over cost of feed
		Lbs.	*Lbs.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
Spring (March, April, and May)	3,196	5,842	236	37.51	19.22	56.73	70.73
Summer (June, July, and August)	1,328	5,941	236	37.62	22.48	60.10	66.59
Fall (September, October, and November)	2,862	6,689	268	38.94	28.45	67.39	76.65
Winter (December, January, and February)	3,484	6,439	258	37.65	25.51	63.16	75.66
Total or average	10,870	6,269	252	37.95	24.06	62.01	73.36

Cows that freshened in the fall months showed the highest average yearly production of milk and butterfat, the highest cost of feed, and the largest income over cost of feed. The cows that freshened in the winter months were second in these respects. On the average those that calved in the spring and summer produced the least milk and butterfat and returned the smallest income over cost of feed.

Breeding records.—A record should be made of date of breeding, the bull to which bred, and the date of expected calving. The gestation period for cows is approximately 280 days. (See 6.01.)

Bedding.—The desirable qualities of a bedding material are bulkiness, large water-holding capacity, high content of fertilizing constituents, and freedom from dust and dirt which would contaminate the milk. Straw and shredded corn fodder are superior to shavings or sawdust in bulkiness. For water-holding capacity the various materials rank as follows: Shredded or cut corn stover, then straw, and little choice between shavings and sawdust for last place. The fertilizing value is greatest with corn stover. Sawdust and shavings have only slight fertilizing value. Shavings are superior to other forms of bedding as regards cleanliness, and for this reason are used considerably in dairies where very clean milk is produced.

Dairy Bulls.—Breeding bulls should be kept in moderate flesh—not fat. Legume hays are the best roughage to feed. From 4 to 10 pounds of grain should be given daily, depending on the size of the animal. A mixture of 3 parts corn or barley, 2 parts bran or oats, and 1 part linseed-oil meal constitutes a desirable ration.

Dairy bulls are old enough for light service at 12 months of age, but should be used sparingly until 18 months old. At 2 years of age, during the breeding season, a bull can serve 4 or 5 cows a week without injury. Mature bulls should not serve more than 2 cows in one day, nor more than 75 or 80 in a year.

The main points to consider in providing quarters for bulls are (1) protection from weather, (2) exercise, and (3) safety in handling.

A shed or barn opening into an exercising yard is practical. If possible, the shed should be left open on the south side. Gates, stanchion, and doors can be so arranged that one need not enter the pen or barn when the bull is loose. The barn should be of sufficient size to enable the bull to move around freely.

Fences should be from 5 to 6 feet high. Materials most commonly used are woven wire, barbed wire, heavy planks, rails or poles, and iron pipe.

Many bulls, after their value has been proved, are found to be sterile or slow breeders, largely on account of close confinement and lack of exercise. Many bulls when provided with a pen are lazy and sluggish and should be forced to exercise. They may be yoked up and worked or put on a treadmill. Two or three bulls can be turned together into the same pen. If this is done, they should be dehorned.

At 8 months of age the bull should have a suitable ring placed in his nose. When the bull is 2 years old this ring should be replaced by a larger and stronger one. The ring is a safeguard in handling and should not be neglected.

Always handle a bull in a firm manner and never trust him. A person may be killed or seriously injured by taking unnecessary chances with a bull.

Animal Nutrition

Feeding Practice.—For greater milk production, liberal feeding is essential. A good dairy cow uses about one-half of her ration for maintaining her body, leaving the remainder for the production of milk. If her ration is reduced one-fourth, this amount comes entirely from the part available for milk production, which in turn is cut by one-half.

In summer, pasture generally is depended upon for feed, but often it must be supplemented by soiling crops or silage, and sometimes by concentrates as well. For winter feeding the ration usually is composed of hay, silage, and a mixture of grains. To balance the ration properly the grain mixture is compounded to fit the roughage, with due consideration for cost, bulk, palatability, and physiological effect upon the cow. For best results cows must be fed individually, salted regularly, and furnished with all the clean water they will drink.

A few simple guides for feeding may be summarized as follows:

(1) Under most circumstances the cow should be fed all the roughage that she will eat up clean, and the grain ration should be adjusted to the milk production.

(2) A grain mixture should be fed in the proportion of 1 pound to each 3 pints or pounds of milk produced daily by the cow. Another rule is 1 pound of grain each day for every pound of butterfat that the cow produces during the week.

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(3) Continue to increase the feed as long as the milk production increases. When the cow begins to put on flesh, cut down the grain.

Rations—*Compounding a grain mixture.*—(1) Make up the mixture to fit the roughage available. With roughage entirely of the low-protein class, the grain should contain approximately from 18 to 22 per cent of protein, but with exclusively high-protein roughage the grain ration need contain only about 13 to 16 per cent.

(2) Select grains that will furnish the various constituents, especially protein, at the least cost, using home-grown grains if possible.

(3) Be sure that the mixture is light and bulky.

(4) The mixture should be palatable.

(5) See that the grain has the proper physiological effect upon the cow.

All these suggestions should be kept in mind in order to obtain the best possible combination of grains.

Approximate digestible protein content of various grains and by-products

AVERAGE 5 PER CENT

Corn meal.
Corn-and-cob meal.
Hominy feed.
Dried beet pulp.

AVERAGE 10 PER CENT

Wheat, ground.
Oats, ground.
Barley, ground.
Rye, ground.
Buckwheat, ground.
Sorghum grains, ground.

AVERAGE 15 PER CENT

Wheat bran.
Wheat middlings.
Velvet beans.

AVERAGE 20 PER CENT

Corn gluten feed.
Malt sprouts.
Coconut meal.
Peanut meal with hulls.
Cowpeas.

AVERAGE 25 PER CENT

Buckwheat middlings.

AVERAGE 30 PER CENT

Corn gluten meal.
Linseed-oil meal (both processes).
Soybeans.

AVERAGE 35 PER CENT

Cottonseed meal.

AVERAGE 40 PER CENT

Peanut meal (hulled nuts).
Soy-bean meal.

The per cent of protein in a grain mixture may be found as follows: Take any number of parts of any number of feeds in the table, and for each part put down the per cent of the heading under which it is found. Add these numbers and divide the sum by the number of parts.

Examples:

1	part wheat bran	15
1	part cottonseed meal	35
1	part gluten feed	20
3	Total	70
	Per cent protein	23.3
3	parts wheat bran (3×15)	45
2	parts cottonseed meal (2×35)	70
1	part gluten feed (1×20)	20
6	Total	135
	Per cent protein	22.5

Grain mixtures with low-protein roughages.—The following grain mixtures are adapted to be fed with roughages of the low-protein class, such as corn silage, corn stover, timothy, prairie, rowen, or millet hays, and cottonseed hulls:

No. 1.—Percentage of digestible protein, 19.8:
- 100 pounds corn meal.
- 100 pounds cottonseed meal.
- 100 pounds linseed-oil meal (old process).
- 200 pounds wheat bran.

No. 2.—Percentage of digestible protein, 19.8:
- 200 pounds corn-and-cob meal.
- 100 pounds cottonseed meal.
- 100 pounds linseed-oil meal (old process).

No. 3.—Percentage of digestible protein, 18.8:
- 200 pounds corn meal.
- 150 pounds cottonseed meal.
- 100 pounds gluten feed.
- 100 pounds wheat bran.

No. 4.—Percentage of digestible protein, 18.1:
- 200 pounds corn meal.
- 100 pounds cottonseed meal.
- 100 pounds oats, ground.
- 100 pounds linseed-oil meal (old process).

No. 5.—Percentage of digestible protein, 18.4:
- 300 pounds corn-and-cob meal.
- 200 pounds cottonseed meal.

Grain mixtures with high-protein roughages.—With roughage of the high-protein class, such as clover, alfalfa, soy beans, cowpeas, and vetch or other legume hay, the following grain mixtures may be used:

No. 6.—Percentage of digestible protein, 14.1:
- 400 pounds corn meal.
- 100 pounds cottonseed meal.
- 100 pounds gluten feed.
- 100 pounds wheat bran.

No. 7.—Percentage of digestible protein, 15.6:
- 400 pounds corn meal.
- 200 pounds gluten feed.
- 200 pounds linseed-oil meal (old process).
- 100 pounds oats, ground.

No. 8.—Percentage of digestible protein, 16.7:
- 300 pounds barley.
- 100 pounds cottonseed meal.
- 100 pounds alfalfa meal.
- 100 pounds wheat bran.

No. 9.—Percentage of digestible protein, 13.7:
- 100 pounds barley.
- 200 pounds coconut meal.
- 100 pounds oats, ground.
- 100 pounds wheat bran.

No. 10.—Percentage of digestible protein, 15.8:
- 300 pounds corn-and-cob meal.
- 200 pounds gluten feed.
- 100 pounds cottonseed meal.
- 100 pounds wheat bran.

Grain mixtures with combination low- and high-protein roughages.—The following grain mixtures are adapted for feeding with a combination of the low and high protein classes of roughage, such as silage and clover, or other legume hay; corn stover and clover, or other legume hay; mixed hay, or oat-and-pea hay:

No. 11.—Percentage of digestible protein, 16.1:
300 pounds corn meal.
100 pounds cottonseed meal.
100 pounds linseed-oil meal (old process).
200 pounds wheat bran.

No. 12.—Percentage of digestible protein, 16.7:
400 pounds corn meal.
100 pounds cottonseed meal.
200 pounds gluten feed.
200 pounds dried brewers' grains.

No. 13.—Percentage of digestible protein, 16.4:
200 pounds corn-and-cob meal.
100 pounds cottonseed meal.

No. 14.—Percentage of digestible protein, 16.7:
200 pounds corn meal.
100 pounds peanut meal (with hulls).
100 pounds cottonseed meal.
100 pounds wheat bran.

No. 15.—Percentage of digestible protein, 16.4:
100 pounds corn meal.
100 pounds oats, ground.
100 pounds cottonseed meal.
100 pounds wheat bran.

The mixtures which contain linseed-oil meal are particularly adapted for use when no succulence is in the ration.

Mineral requirements.—Lime and phosphorus are used in comparatively large quantities by dairy cattle in building bone and producing milk. Heavy-milking cows should be fed some form of properly cured legume hay which will furnish a relatively large amount of calcium. They should also be fed bran to furnish phosphorus. It is inadvisable to add a mineral mixture to a ration which contains liberal quantities of legume hay and of wheat bran. If nonleguminous hay and stover are used, or if there is other evidence of lack of mineral matter in the ration, it is advisable to add to each 100 pounds of grain 3 to 4 pounds of a mineral mixture consisting of 1 pound ground limestone, 1 pound steamed bonemeal, and 1 pound floats (rock phosphate). However, the results obtained by this method of feeding are much inferior to those obtained by the use of a well-cured legume hay.

Cows on pasture are less likely to show a lack of mineral matter in the ration than those on winter feed. This is probably because pasture, even nonleguminous, contains a larger amount of certain vitamins that assist in calcium assimilation than does dry roughage. It is advisable, however, to add a mineral mixture as given above to the grain of high-producing cows whose only roughage is nonleguminous pasture.

Dairy Buildings

Types of Barns.—The types of barns which can be made suitable for dairy cows are the basement barn, one-story stable, two-story barn, round barn, and open shed or covered barnyard.

In the basement barn the cows usually are housed on the lower floor, with space for feed storage above. This type is likely to be warmer in the winter than other types. However, care should be taken to provide sufficient light, ventilation, and drainage.

The one-story and two-story barns can be well lighted and ventilated and kept in a sanitary condition more easily than can the basement barns. With a one-story stable other facilities must be provided for the storage of hay. For this reason the expense of housing both cows and feed, on most farms, will be greater with the one-story barn than with the two-story barn.

In the round barn more space can be inclosed with the same quantity of building material than in other types. The practice of locating the silo in the center of a round barn may put the silage in the most convenient place for feeding, but it is likely to fill the stable with odors that may taint the milk. A silo so located is not so easily filled as one outside the barn.

The open shed or covered barnyard provides the best-known method of saving and preserving the manure. It permits the feeding under shelter of rough material such as cornstalks and makes possible their utilization for bedding. With plenty of bedding this system of housing will keep the cows cleaner than when they are confined in the stables.

Stall dimensions for different-sized cows

Size of cow	Length to gutter	Width	Manger
	Inches	*Inches*	*Inches*
Large	60 to 64	44 to 48	28 to 30
Medium	54 to 58	40 to 42	24 to 26
Small	48 to 52	36 to 38	20 to 22

The gutter should be 6 to 8 inches deep and 16 to 20 inches wide and the slope of the bottom one-half inch away from the stall.

The stall floor should slope toward the gutter 1 inch in the rear two-thirds of its length. The one-third next to the stanchion should be level and dropped one-half inch below the level of the stall floor.

The bottom of the manger should be about 2 inches higher than the stall floor in front.

Whitewashing.—Cow stables should be whitewashed or painted once or twice a year. Many whitewash formulas require that other substances, such as salt or skim milk, be added to the lime and water. However, satisfactory whitewash can be made by the use of lime and water only. The ordinary hydrate of lime makes a good whitewash, or the quicklime ordinarily called lump lime may be slacked with a minimum quantity of water, and thus used in place of the commercially prepared hydrate of lime. Do not use air-slaked lime. Whitewash may be applied with a brush or with a spray pump.

Ice House—*Size needed.*—Where cream only is to be cooled allow at least one-half ton of ice per cow. For cooling milk allow 1½ tons per cow. These quantities should be enough to leave a margin for household use, but it is better to have too much than too little. Whenever practicable build the ice house in the form of a cube. Allow 45 cubic feet of space for each ton of ice.

Location, drainage, insulation, ventilation.—Locate the ice house in a shady place near the dairy house where

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there is good natural drainage. If water from the melting ice is not removed, melting will proceed at a more rapid rate. If the house is built on sloping, porous ground, natural drainage should be sufficient, but if on a clay soil artificial drainage should be provided.

Use plenty of insulation. If sawdust or mill shavings are used, see that they are dry. Commercial insulation is more efficient and durable than either but is more expensive. Wooden houses insulated with sawdust or mill shavings should be ventilated. Houses with commercial insulation and a cement finish need no ventilation.

Ice supply.—Be sure the supply of water is pure. Clear the pond or stream of vegetable matter, otherwise it will be frozen in the ice. Protect the water from drainage from contaminating sources, such as privies, barnyards, and refuse heaps. Keep the ice surface clear of snow, as it retards freezing. Mark off the surface into cakes of the desired size, being sure that the lines form rectangles. Cut out a strip of ice the width of the cake desired. Force this strip under the surface of the ice field, thus opening a channel to the landing. Saw off large cakes and float them to the landing, where they may be cut into smaller cakes.

Tools required.—For the average farm the only tools required are 2 saws, 2 pairs of tongs, 2 ice hooks, 1 pointed bar, 1 straight board for marking.

MARKET MILK AND CREAM

Sanitary Production

General.—Clean milk is easily produced if a few simple rules are followed.

Clean and healthy cows.—(1) Cows should be tested for tuberculosis once a year. (2) If reactors are found, retest in six months. (3) Groom cows and keep them free from dirt. (4) Before milking wipe cows' udders with clean, damp cloth. (5) If udders are dirty, wash with clean water.

Use small-top milk pails.—(1) Small-top milk pails prevent much dirt from falling into milk. (2) Dirt carries bacteria which are harmful to milk. (3) Contamination should be kept out, for it can not be strained out. (4) Small-top pails can be made by a tinner from ordinary pails.

Sterilize all milk utensils.—(1) Unsterilized utensils cause most of the bacterial contamination in freshly drawn milk. (2) Bacteria cause losses through souring and low-grade products. (3) Rinse utensils, including cooler, immediately after using with cold or lukewarm water. (4) Scrub with hot water and washing powder, using a stiff brush. (5) Sterilize with steam or boiling water for five minutes. (6) Invert in a clean place to dry.

Cool milk promptly.—(1) Milk should be aerated and cooled as soon as it is drawn. (2) Aeration drives off or lessens undesirable flavor and odors. (3) Cooling checks growth of bacteria and delays souring. (4) Cool milk quickly to 50° F. and keep it cold until consumed.

Milking Machine.—The mechanical milker saves labor, is easier, and to many persons its operation is more agreeable than hand milking. The cost of installation and the labor of keeping the machines in proper sanitary condition makes them impractical if the herds are very small. It is possible to have milk with a low bacteria count when it is machine-drawn if proper attention is given to cleansing and sterilizing.

So far as the quantity of production is concerned, the mechanical milker seems to give as good results as ordinary hand milking, but no better than the best hand milking. It is the general practice for a hand milker to follow the machine to see that the milking is completely done, and to draw any milk that is left. Failures with the mechanical milker can usually be traced to a lack of mechanical knowledge on the part of the operator, to carelessness of operation, or to lack of attention to proper cleaning of the machine.

Cream Separator.—The main factors that cause a variation in the test of cream from the same separator are as follows:

Speed of the separator bowl.—The higher the speed of the bowl the smaller the quantity of cream and the higher the test. The test of cream from a hand separator usually varies somewhat because it is very difficult to operate the machine at exactly the same speed from day to day unless a speedometer or a timing device is used.

Variation in the quantity of liquid used to flush the bowl.—When the bowl is flushed after the separating,

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some of the liquid (skim milk should be used rather than water) usually runs into the cream and reduces the test. When the quantity of cream is small this is an important factor.

Variation in richness of milk separated.—Other things being equal, high-testing milk produces higher-testing cream than does low-testing milk.

Temperature of milk separated.—A richer cream will be obtained when milk is separated at a low temperature. A loss of butterfat in the skim milk may result if the milk is separated too cold.

Rate of flow through the bowl.—A reduction in the flow of milk into the bowl because of some obstruction, a partly closed cock, or an obstruction inside the bowl reducing the quantity of milk flowing through the bowl will result in a richer cream. An obstruction in the cream outlet may cause some of the cream to run out with the skim milk. One cause of obstructions in the bowl is failure to wash the separator every time it is used.

Adjustment of the cream screw.—A high-testing or a low-testing cream may be obtained by the proper adjustment of the cream screw, but because of the five factors mentioned above this adjustment can not overcome the minor variations in test.

Cooling.—A cooling tank, built in the milk house, is essential for final cooling and storage of the freshly drawn milk. The best type is made with a 2-inch layer of cork between a double shell of 4-inch concrete. One made of 2-inch plank is next best. Tanks of plain concrete or metal require more ice for cooling.

Size of tank.—The capacity of the tank should be 3 gallons of water for each gallon of milk when ice is used; otherwise the capacity should be doubled. The cans should be set in the tank on a rack so that the water can circulate under them. Arrange a drain so that the tank can be emptied and cleaned frequently. Water should enter tank near the bottom.

Directions for cooling.—(1) Have the tank water at 40° F. or lower before milking. In addition, at least 2 pounds of ice are needed for every gallon of milk to be stored, provided the milk is previously cooled to 58° F. or below over the surface cooler. (2) Start water running through the surface cooler. For every gallon of milk or cream cooled, 10 or 15 gallons of water should pass through the cooler. (3) Pour milk over the cooler as soon as drawn from the cow. Cool cream as soon as separated. (4) Milk should flow slowly over the cooler and be cooled to within 3° of the temperature of the water. (5) When a can is filled from the surface cooler set it into the tank immediately. Always have ice in the tank when cream or milk is being stored, unless the water is below 45° F. The water should always reach the necks of the cans. (6) Keep cans in storage tank until ready to ship. During the hauling protect them with blanket or felt jackets.

Pasteurization of Milk.—Pasteurization is the process of heating milk to a temperature of 145° F. and holding every portion of it at that temperature for at least 30 minutes, after which it should be immediately cooled to 50° or below. This process absolutely kills bacteria capable of causing diseases, yet it does not injure the chemical or nutritive value of milk appreciably. In short, Pasteurization is an added safeguard without serious disadvantages and benefits both producer and consumer.

Food Value

Composition of cow's milk

Constituents	Per cent
Water	87.0
Fat	4.0
Carbohydrates: Milk sugar	5.0
Protein:	
Casein	2.8
Albumin	.5
Mineral matter	.7
Total	100.0

Vitamins in Milk.—The vitamins are substances necessary for normal health, growth, and development of the body. Unless these are provided in the food, underdevelopment and illness will result, which may become serious or fatal if the deficiency is long continued. Although some vitamins are present in small amounts only, milk contains all the known vitamins and is particularly rich in vitamin A, which is contained in the cream or butterfat. When this vitamin is lacking in the diet growth is checked, and liability to serious eye diseases and other infections is increased. The vitamin A content of milk is believed to vary somewhat at different seasons, since it is influenced by the amount of vitamins in the cow's ration.

Body Needs.—One pint of whole milk supplies 9 per cent of the energy that a man at moderate labor needs daily, 15 per cent of the protein, 80 per cent of the calcium, 32 per cent of the phosphorus, and 6 per cent of the iron.

Fat and sugar furnish body fuel. One quart of whole milk contains about 1¼ ounces of fat. The milk sugar in a quart of either skim milk or whole milk would fill three tablespoons.

Protein is used to build and repair muscle and other body tissue. Milk in any form, whether whole, skimmed, or as buttermilk, or even whey, and as cheese, is an efficient source of protein.

Calcium, phosphorus, and iron are the mineral constituents of milk that are especially important to the body. Calcium, or lime, is the chief constituent of bones and teeth. It is also needed in the blood and muscle, and is necessary to keep the heart beating normally. Phosphorus is a prominent constituent of bones as well as of all the soft body tissues. Iron is a necessary part of the blood. Although there is only a small amount of iron in milk, it is completely utilized by the body.

Buttermilk is a nutritious, healthful beverage and may also be used in cookery in practically the same way as sour milk. Because the casein in buttermilk is often more easily digested than that in ordinary milk, buttermilk is a food of special value for many persons having digestive difficulties.

Butter is one of the most palatable and digestible fats available. It furnishes heat and energy to the body and is especially valuable since it contains vitamin A in abundance.

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Cheese has a high nutritive value, being particularly high in protein or muscle-forming materials.

Skim milk contains much less fat than whole milk, but has the protein, carbohydrates, and mineral matter. It may greatly increase the nutritive value of the diet if used freely in cooking.

Condensed, evaporated, and dried milk may be used for many purposes in place of fresh milk where the latter is not available. For feeding children, however, these products may not entirely take the place of fresh milk and should be supplemented by fruit juices and fresh green vegetables.

Milk Campaign.—An educational milk campaign as ordinarily conducted is an organized effort of a community to improve the health of its citizens and to reduce undernourishment, especially among children, by encouraging an adequate consumption of milk. There are three distinct parts of a milk campaign: First, preliminary organization; second, the intensive period; third, the follow-up.

Before a campaign of this kind is organized certain facts should be ascertained: (1) Is there sufficient milk to permit an increased consumption of about 10 to 20 per cent? (2) Is the milk of good quality? (3) What is the total daily consumption of milk? (4) The per capita consumption? (5) The price per quart? (6) Will the local dairyman agree not to raise the price because of increased demand? (7) What percentage of the children are poorly nourished? (8) Will the county and city schools and the board of health cooperate? (9) Will the campaign have the support of the press?

If the above facts seem to justify the work the next step is to call a community meeting. Invitations are extended to representatives of organized groups interested in the public welfare. Cards for the names, addresses, telephone numbers, and organizations represented are prepared by a county extension worker. The cards are filled out by the representatives attending the meeting and are left by them with the secretary of the meeting. From this list committee members are chosen. The county agent or some other person familiar with extension work usually acts as temporary chairman of this meeting. The program consists of the following discussions: (1) Purpose of the campaign. (2) Campaigns in other States. (3) Does the community need a campaign? (4) What will the college do to assist? (5) What will the local organizations do to assist?

A vote is then taken to ascertain the wishes of these representative citizens, and if the plan is adopted a small executive committee is chosen, headed by a recognized leader of high standing. The executive committee in turn selects a chairman of each of the following working committees: (1) Finance, (2) school activities, (3) news stories and advertising, (4) exhibits, (5) bulletins and other publications, (6) speakers' schedules, (7) motion pictures, (8) transportation, (9) photographs, and (10) scrapbook.

The committee chairmen should be chosen with reference to their special fitness for the work to be done. Each committee should have a representative of the college extension staff as a member. The committee's duties should be specifically outlined, giving such points as: (1) What is to be done? (2) When is it to be done? (3) How is it to be done? (4) By whom is it to be done?

Both plans and reports of work done should be presented in writing by the committee chairman to the executive committee. To be of lasting value plenty of time should be allowed for organization. Two months is not too long for the committees to do the preliminary work. Announcements of the intensive campaign are made in the papers just before this stage of the work begins. In cities the mayor issues a proclamation, thus giving the work an official stamp of approval. A period of two weeks is about as long as daily space can be procured in city newspapers, and during this time every group, both children and adults, hears the milk-for-health message directly or by radio, reads the message, or sees it by means of posters, billboards, exhibits, and the like. If possible, the speakers should be extension workers or trained leaders in health work. Often it has been found necessary to give the teachers the stories to tell, and in one city the pupils in the home-economics classes of the high school went back to their grade schools and gave the talks to the grade children. In all cases of this kind better results are usually obtained if some one familiar with the plan and the subject matter presented in the stories explains all policies to those who are to be speakers, as well as actually telling the stories to them. The effectiveness of a story often depends upon the manner in which it is presented.

For the follow up one or two years are required. This work consists of the following: (1) A check is kept of the milk sales, home and school, in both city and county; (2) milk-feeding groups are organized and their weights recorded at regular intervals for about nine months or more; (3) school health departments obtain weights and measures of all the children within four to nine months after the intensive part of the campaign, and these are compared with the precampaign weights; (4) daily milk consumption by school children is recorded at intervals corresponding with the weighing periods; (5) follow-up stories are given to teachers and to the press.

Helps and suggestions may be procured from the United States Department of Agriculture, Bureau of Dairy Industry.

Testing

Butterfat.—The following steps should be taken in making the Babcock test of milk.

(1) Be sure the sample represents the lot of milk to be tested.

(2) Temper the milk to 60° to 70° F.

(3) Mix well by pouring back and forth.

(4) Measure out 17.6 cubic centimeters with pipette, and put into milk test bottle.

(5) Add 17.6 cubic centimeters sulphuric acid (sp. gr. 1.83).

(6) Mix thoroughly, with circular motion.

(7) Whirl in centrifuge for five minutes at proper speed.

(8) Add clean, hot, soft water up to base of neck.

(9) Whirl two minutes, at same speed.

(10) Add clean, hot, soft water to bring fat into neck.

(11) Warm the centrifuge before last whirling.

(12) Whirl one minute, same speed.

(13) Temper tests in water bath for five minutes, 130° to 140° F.

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(14) Read with dividers from extremes of fat column.
(15) Empty bottles while still hot.
(16) Wash at once in alkali solution, using brush in neck.
(17) Rinse in clear, hot water, and drain.

Solids not Fat.—For estimating solids not fat (SNF) in milk, from corrected Quevenne lactometer reading (L) and percentage of butterfat (F), use formula:

$$SNF = \tfrac{1}{4}L + .2 \times F$$

To correct lactometer reading between 50° and 70° F., add 0.1 to the lactometer reading for each degree in temperature above 60; subtract 0.1 for each degree below 60.

Comparison of metric and customary weights and measures

Customary weights and measures	Equivalents in metric system	Metric weights and measures	Equivalents in customary system
1 inch	2.54 centimeters.	1 meter	39.37 inches.
1 foot	0.3048 meter.	1 meter	1.0936 yards.
1 square inch	6.452 square centimeters.	1 square centimeter.	0.155 square inch.
1 square foot	9.29 square decimeters.	1 square meter	10.764 square feet.
1 cubic inch	16.387 cubic centimeters.	1 cubic centimeter.	0.061 cubic inch.
1 cubic foot	0.0283 cubic meter.	1 cubic centimeter.	0.0338 fluid ounce.
1 fluid ounce	29.57 cubic centimeters.	1 cubic decimeter.	61.023 cubic inches.
1 quart	0.9464 liter.	1 liter	1.0567 quarts.
1 gallon	3.7854 liters.	1 dekaliter	2.6417 gallons.
1 grain	64.8 milligrams.	1 gram	15.43 grains.
1 ounce (avoirdupois).	28.35 grams.	1 gram	0.035274 ounce.
1 pound (avoirdupois).	0.4536 kilogram.	1 kilogram	2.2046 pounds (avoirdupois).

To convert degrees Fahrenheit to degrees Centigrade, subtract 32, multiply by 5, and divide by 9.

To convert degrees Centigrade to degrees Fahrenheit, multiply by 9, divide by 5, and add 32.

Scoring

Sanitary Inspection of Dairy Farms—

Score card for dairy farms

[Indorsed by the Dairy Science Association]

Equipment		Perfect score
COWS		
Health		6
Apparently in good health	1	
If tested with tuberculin within a year and no tuberculosis is found, or if tested within six months and all reacting animals removed	5	
(If tested within a year and reacting animals are found and removed, 3.)		
Food (clean and wholesome)		1
Water (clean and fresh)		1
STABLES		
Location of stable		2
Well drained	1	
Free from contaminating surroundings	1	
Construction of stable		4
Tight, sound floor and proper gutter	2	
Smooth, tight walls and ceiling	1	
Proper stall, tie, and manger	1	
Provision for light: 4 sq. ft. of glass per cow		4
(Three sq. ft., 3; 2 sq. ft., 2; 1 sq. ft., 1; deduct for uneven distribution.)		
Bedding		1
Ventilation		7
Provision for fresh air, controllable flue system	3	
(Windows hinged at bottom, 1.5; sliding windows, 1; other openings, 0.5.)		
Cubic feet of space per cow, 500 ft	3	
(Less than 500 ft., 2; less than 400 ft., 1; less than 300 ft., 0.)		
Provision for controlling temperature	1	

Methods		Perfect score
COWS		
Clean		8
(Free from visible dirt, 6.)		
STABLES		
Cleanliness of stables		6
Floor	2	
Walls	1	
Ceilings and ledges	1	
Mangers and partitions	1	
Windows	1	
Stable air at milking time		5
Freedom from dust	3	
Freedom from odors	2	
Cleanliness of bedding		1
Barnyard		2
Clean	1	
Well drained	1	
Removal of manure daily to 50 feet from stable		2
MILK ROOM OR MILK HOUSE		
Cleanliness of milk room		3
UTENSILS AND MILKING		
Care and cleanliness of utensils		8
Thoroughly washed	2	
Sterilized in steam for 15 minutes	3	
(Placed over steam jet, or scalded with boiling water, 2.)		
Protected from contamination	3	
Cleanliness of milking		9
Clean, dry hands	3	
Udders washed and wiped	6	
(Udders cleaned with moist cloth, 4; cleaned with dry cloth or brush at least 15 minutes before milking, 1.)		

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Score card for dairy farms—Continued

Equipment	Perfect score	Methods	Perfect score
UTENSILS		HANDLING THE MILK	
Construction and condition of utensils	1	Cleanliness of attendants in milk room	2
Water for cleaning (Clean, convenient, and abundant.)	1	Milk removed immediately from stable without pouring from pail	2
Small-top milking pail	5	Cooled immediately after milking each cow	2
Milk cooler	1	Cooled below 50° F (51° to 55°, 4; 56° to 60°, 2.)	5
Clean milking suits	1	Stored below 50° F (51° to 55°, 2; 56° to 60°, 1.)	3
MILK ROOM OR MILK HOUSE		Transportation below 50° F (51° to 55°, 1.5; 56° to 60°, 1.) (If delivered twice a day, allow perfect score for storage and transportation.)	2
Location: Free from contaminating surroundings	1		
Construction of milk room	2		
Floor, walls, and ceilings 1			
Light, ventilation, screens 1			
Separate rooms for washing utensils and handling milk	1		
Facilities for steam (Hot water, 0.5.)	1		
Total	40	Total	60

Equipment + Methods = Final score.

NOTE 1.—If any exceptionally filthy condition is found, particularly dirty utensils, the total score may be further limited.

NOTE 2.—If the water is exposed to dangerous contamination, or there is evidence of the presence of a dangerous disease in animals or attendants, the score shall be 0.

Score Card for Milk.—

Bacteria per cubic centimeter: Perfect score, 35

Quantity	Points	Quantity	Points
500 and under	35.0	18,001 to 19,000	31.3
501 to 1,000	34.9	19,001 to 20,000	31.1
1,001 to 1,500	34.8	20,001 to 21,000	30.9
1,501 to 2,000	34.7	21,001 to 22,000	30.7
2,001 to 2,500	34.6	22,001 to 23,000	30.5
2,501 to 3,000	34.5	23,001 to 24,000	30.3
3,001 to 3,500	34.4	24,001 to 25,000	30.1
3,501 to 4,000	34.3	25,001 to 30,000	28.6
4,001 to 4,500	34.2	30,001 to 35,000	27.1
4,501 to 5,000	34.1	35,001 to 40,000	25.6
5,001 to 6,000	33.9	40,001 to 45,000	24.1
6,001 to 7,000	33.7	45,001 to 50,000	22.6
7,001 to 8,000	33.5	50,001 to 55,000	20.6
8,001 to 9,000	33.3	55,001 to 60,000	18.6
9,001 to 10,000	33.1	60,001 to 65,000	16.6
10,001 to 11,000	32.9	65,001 to 70,000	14.6
11,001 to 12,000	32.7	70,001 to 75,000	12.6
12,001 to 13,000	32.5	75,001 to 80,000	10.6
13,001 to 14,000	32.3	80,001 to 85,000	8.6
14,001 to 15,000	32.1	85,001 to 90,000	6.6
15,001 to 16,000	31.9	90,001 to 95,000	4.6
16,001 to 17,000	31.7	95,001 to 100,000	2.6
17,001 to 18,000	31.5	Over 100,000	0

NOTE.—When the number of bacteria per cubic centimeter exceeds the local legal limit the score shall be 0.

Flavor and odor: Perfect score, 15.—Deductions for disagreeable or foreign odor or flavor should be made according to conditions found. When possible to recognize the cause, it should be described under "Remarks."

Sediment: Perfect score, 10.—Examination for sediment may be made by means of a sediment tester, and the resulting cotton disks compared with standards; or the sediment may be determined by examination of the bottom of the milk in the bottle. In the latter case the milk should stand undisturbed for at least an hour before the examination. Raise the bottle carefully in its natural upright position until higher than the head. Tip slightly and observe the bottom of the milk with the naked eye or by the aid of a reading glass. The presence of the slightest movable speck makes a perfect score impossible. Further deductions should be made according to the quantity of sediment found. When possible, the nature of the sediment should be described under "Remarks."

Fat in milk: Perfect score, 15.—Anything below the local legal minimum shall be scored 0. City, State, or contest officials shall decide the percentage of fat to be allowed a perfect score and shall indicate the gradations in score between 0 and 15 points.

Solids not fat: Perfect score, 15.—Anything below the local legal minimum shall be scored 0. City, State, or contest officials shall decide the percentage of solids not fat to be allowed a perfect score, and shall indicate the gradations in score between 0 and 15 points.

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Temperature (street samples): Perfect score, 5[1]

Degrees	Points	Degrees	Points
50° F. and below	5	57° to 60°	1
51° to 53°	4	Above 60°	0
54° to 56°	3		

Acidity (prepared samples): Perfect score, 5[1]

Per cent	Points	Per cent	Points
0.2 and less	5	0.23	2
0.21	4	0.24	1
0.22	3	Over 0.24	0

[1] Use temperature or acidity according to source of sample. If only one is used the total score comes to 100. If milk is picked up from wagons or stores, use temperature. If it is sent in, use acidity.

Bottle and cap: Perfect score, 5.—Deductions in score should be made for dirty or chipped bottles, for caps which do not cover the lips of the bottles, or do not fit properly in the cap seats.

Score Card for Cream.—

Bacteria per cubic centimeter: Perfect score, 35

Quantity	Points	Quantity	Points
500 and under	35.0	25,001 to 30,000	29.0
501 to 1,000	34.9	30,001 to 35,000	28.0
1,001 to 1,500	34.8	35,001 to 40,000	27.0
1,501 to 2,000	34.7	40,001 to 45,000	26.0
2,001 to 2,500	34.6	45,001 to 50,000	25.0
2,501 to 3,000	34.5	50,001 to 55,000	24.0
3,001 to 3,500	34.4	55,001 to 60,000	23.0
3,501 to 4,000	34.3	60,001 to 65,000	22.0
4,001 to 4,500	34.2	65,001 to 70,000	21.0
4,501 to 5,000	34.0	70,001 to 75,000	20.0
5,001 to 6,000	33.8	75,001 to 80,000	19.0
6,001 to 7,000	33.6	80,001 to 85,000	18.0
7,001 to 8,000	33.4	85,001 to 90,000	17.0
8,001 to 9,000	33.2	90,001 to 95,000	16.0
9,001 to 10,000	33.0	95,001 to 100,000	15.0
10,001 to 11,000	32.8	100,001 to 120,000	12.5
11,001 to 12,000	32.6	120,001 to 140,000	10.0
12,001 to 13,000	32.4	140,001 to 160,000	7.5
13,001 to 14,000	32.2	160,001 to 180,000	5.0
14,001 to 15,000	32.0	180,001 to 200,000	2.5
15,001 to 20,000	31.0	Above 200,000	0
20,001 to 25,000	30.0		

NOTE.—When the number of bacteria per cubic centimeter exceeds the local legal limit the score shall be 0.

Flavor and odor: Perfect score, 25.—Deductions for disagreeable or foreign odor or flavor should be made according to conditions found. When possible to recognize the cause of the difficulty it should be described under "Remarks."

Sediment: Perfect score, 10.—Examination for sediment should be made only after the cream has stood for at least an hour undisturbed in any way. Raise the bottle carefully in its natural upright position until higher than the head. Tip slightly and observe the bottom of the cream with the naked eye or by the aid of a reading glass. The presence of the slightest movable speck makes a perfect score impossible. Further deductions should be made according to the quantity of sediment found. When possible the nature fo the sediment should be described under "Remarks."

Fat in cream: Perfect score, 20

Per cent	Points	Per cent	Points
25 and above	20	19	17
24	19. 5	18	16
23	19	17	12
22	18. 5	16	8
21	18	15	4
20	17. 5	Less than 15	0

NOTE.—When the percentage of fat is less than the local legal limit the score shall be 0.

Temperature or acidity: Perfect score, 5.—Same as for milk.

Bottle and cap: Perfect score, 5.—Same as for milk.

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MILK PRODUCTS

Yield of different products from 100 pounds of 4 per cent milk

Products	Yield	By-products	Yield
	Pounds		*Pounds*
Butter	4.8	Skimmed milk	88
		Buttermilk	7
Cheddar cheese	10.6	Whey	89.0
		Whey butter	.36
Swiss cheese	8.5	Whey	90
		Whey butter	.9 to 1.2
Limberger cheese	12–13	Whey	85
		Whey butter	.36
Neufchâtel cheese	14–15	Whey	82
		Whey butter	.36
Condensed milk [1]	40	None	
Evaporated milk [2]	48.9	None	
Milk powder	12.9	None	

[1] One hundred five pounds of milk plus 16.8 pounds of sugar make one case of 48 14-ounce cans.
[2] One hundred six pounds of milk make one case of 48 16-ounce cans.

Yield from 100 pounds of skim milk

Product	Yield	By-product	Quantity
	Pounds		*Pounds*
Casein	3 to 3¼	Whey	95
Cottage cheese	14 to 17	Whey	80
Powder	10	None	

Butter

Farm Butter Making.—Butter making begins with the production of the milk. Good butter can be made only from good, clean-flavored cream. To obtain practically all the cream from the milk and to have it in the best condition requires the use of a cream separator.

The thorough cleaning and sterilizing of all dairy utensils is essential to the production of butter of good flavor.

Cream for butter making should contain about 30 per cent butterfat. A gallon of such cream will yield about 3 pounds of butter.

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Cream should be kept as cold as possible until time for ripening, when it should be warmed to 65° to 75° F. and held at that temperature until a mild-acid flavor is developed.

A thermometer should always be used in order that the operator may know that proper temperatures have been obtained.

Cream that is overripe (too sour) makes poor butter.

The churning temperature should be such that (1) the churning will require from 30 to 40 minutes, and (2) the butter granules will be firm without being hard, usually from 52° to 60° F. in summer and from 58° to 66° in winter.

All churning utensils should be cleaned, scalded, and cooled before they are used.

The churn should be stopped when the butter granules are the size of grains of wheat.

The butter, in the granular condition, should be washed twice with pure water at about the same temperature as the buttermilk.

Salt should be added at the rate of about three-quarters of an ounce to the pound of butter.

Butter should be worked carefully until the salt is evenly distributed and a solid, smooth body is formed. The best butter has a waxy body, a bright appearance, and, when a slab is broken, a grain like broken steel.

Overworked butter has a sticky, salvy body, a dull, greasy appearance, and a gummy grain. It deteriorates more rapidly than properly worked butter.

Mottled butter is caused by the uneven distribution of salt.

Butter for the market should be in prints, wrapped in parchment paper, and inclosed in paraffined cartons.

Normal Overrun for Butter.—Overrun is the increase of butter over butterfat, owing to the inclusion with the fat of water, salt, curd, and ash.

Legal butter must contain at least 80 per cent butterfat, and in order to be safely above the legal limit should contain 80.5 per cent butterfat. Medium salted butter contains 3 per cent salt. The curd and ash content is about 1 per cent. A desirable composition of butter is as follows: 80.5 per cent butterfat, 15.5 per cent water, 3 per cent salt, 1 per cent curd and ash.

To calculate overrun—1,000 pounds cream churned—test 32 per cent—320 pounds butterfat—393 pounds butter made. Overrun equals 393—320=73 pounds. Per cent overrun equals $73 \div 320 = 22.81$ per cent. The buttermilk should not contain over 0.2 per cent butterfat as determined by the Babcock test.

Butter score card

Item	Scale
Flavor	45
Body	25
Color	15
Salt	10
Package	5
Total	100

Cheese

Yield of Cheddar cheese from milk of varying fat content

Fat in the milk	Yield	Fat in the milk	Yield
Per cent	*Pounds*	*Per cent*	*Pounds*
3.00	8.3	4.25	11.17
3.25	8.88	4.50	11.74
3.50	9.45	4.75	12.31
3.75	10.03	5.00	12.90
4.00	10.60		

Cheese score card

Item	Scale
Flavor	30
Body and texture	40
Finish and appearance	20
Color	10
Total	100

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8. ENTOMOLOGY

.0 General.
.1 Cultivated-plant insects.
.10 General.
.11 Cereal and forage insects.
.110 General.
.111 Corn.
.112 Wheat.
.113 Alfalfa.
.114 Clover.
.115 Soy bean and cowpea.
.116 Kafir and milo maize.
.117 Other small grains.
.118 Grass.
.119 Miscellaneous.
.12 Fruit insects.
.120 General.
.121 Apple.
.122 Pear.
.123 Peach.
.124 Plum.
.125 Cherry.
.126 Grape.
.127 Currant and gooseberry.
.128 Citrus and subtropical fruits.
.129 Miscellaneous.
.13 Truck-crop insects.
.130 General.
.131 Potato.
.132 Tomato.
.133 Cucumbers and melons.
.134 Bean.
.135 Cabbage.
.136 Peas.
.137 Strawberry.
.138 Onion.
.139 Miscellaneous.
.14 Southern field-crop insects.
.140 General.
.141 Cotton.
.142 Tobacco.
.143 Sugar cane.
.144 Rice.
.145 Peanut.
.149 Miscellaneous.
15 Greenhouse insects.
.150 General.
.151 Rose.
.152 Chrysanthemum.
.153 Carnation.
.154 Snapdragon.
.155 Sweet pea.
.156 Violet and pansy.
.157 Potted and bedding plants.
.159 Miscellaneous.
.16 Ornamental-plant insects.
.160 General.
.161 Rose.
.162 Bulbous plants.
.163 Perennial plants.
.164 Annual plants.
.165 Climbers.
.166 Woody deciduous shrubs.
.167 Evergreen shrubs.
.168 Aquatic plants.
.169 Miscellaneous.
.19 Miscellaneous plant insects.

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.2 Man and domestic-animal pests.
.20 General.
.21 Man.
.22 Cattle.
.23 Hog.
.24 Horse and mule.
.25 Sheep and goat.
.26 Cat and dog.
.27 Poultry.
.29 Miscellaneous.
.3 Forest and shade-tree insects.
.30 General.
.31 Bark beetles.
.32 Other insects affecting trees.
.33 Crude forest products.
.34 Finished forest products.
.35 Rustic work.
.36 Termites.
.37 Nursery trees and seeds.
.38 Shade trees.
.39 Miscellaneous.
.4 Stored-product and household insects.
.40 General.
.41 Grain and grain products.
.42 Bean and pea.
.43 Drugs.
.44 Tobacco products.
.45 Fabrics.
.46 Hides, feathers, and hair.
.47 Meats and dairy products.
.48 Dried fruits.
.49 Miscellaneous.
.5 Beekeeping.
.50 General.
.51 Bee behavior and physiology.
.52 Management.
.53 Honey crop.
.54 Wintering.
.55 Diseases.
.56 Marketing.
.57 Beekeeping regions.
.59 Miscellaneous.
.7 Control of insects.
.70 General.
.71 Natural.
.72 Cultural.
.73 Stomach poisons.
.74 Contact poisons.
.75 Fumigants.
.76 Repellents.
.77 Trapping devices.
.78 Machinery.
.780 General.
.781 Spray.
.782 Dusting.
.789 Miscellaneous.
.79 Miscellaneous.
.8 Regulatory work.
.80 General.
.89 Miscellaneous.
.9 Miscellaneous.
.91 Sericulture.
.92 Lac insects.
.93 Flax insects.
.99 Bibliography of literature on entomology.

ENTOMOLOGY

CULTIVATED-PLANT INSECTS

Cereal and Forage Insects

General Pests—*Grasshoppers.*—The entire consumption of the foliage of plants and the presence of grasshoppers in large numbers indicate a grasshopper outbreak. The eggs of these insects are deposited in packets in compact soil during late summer and early fall, and most of the species overwinter in this stage. The eggs hatch in April or May, and the young grasshoppers closely resemble their parents, but have no wings. They begin feeding almost immediately after hatching. Hot, dry weather is favorable, but cool, wet weather is unfavorable to them. With the common species there is but one generation per year.

Control: Watch for young hoppers, especially in alfalfa, and begin to poison them with bran mash immediately, where they appear in considerable numbers. Sow broadcast throughout infested fields at rate of 8 to 12 pounds per acre, depending on amount of infestation. The poison bait should be sown between 7 and 9 a. m. Repeat in a few days if necessary. Keep supply of poisoning materials out of reach of farm animals. Do not distribute this bait in lumps or heaps. Where sown thinly it will not endanger stock. Destroy eggs where possible by plowing or disking roadsides, ditch banks, and uncultivated lands.

Cutworms.—See Truck-Crop Insects.

Control: East of meridian 100—plow sod land intended for corn in summer or early fall of previous year. Use poisoned bait.

White grubs.—Large soft grubs with white, curved bodies and brown heads found in moist soil. These are larvæ of robust, smooth beetles varying from yellow to brown in color and commonly known as May beetles or June bugs. Eggs are laid singly in the soil, and the grubs require one to two and a half years for their development. They feed on roots and root crops, eating large holes in potatoes. The pupa is found in the soil. The beetles are also injurious but mostly to shrubs and trees.

Control: Plow infested lands thoroughly before October 1, and sow to clover or small grains. Do not plant corn, potatoes, or other wide-row crops on infested lands. Spray food trees of beetles with lead arsenate, applying when beetles are first noticed in the spring.

Wireworms.—Plants stunted and wilting or dying. Fleshy root crops show injury in the nature of small holes bored into the roots. Hard, shining, yellow or reddish-brown worms are found associated with the injured roots. The eggs are deposited in the soil by a flat, elongated beetle, usually brown and commonly known as click or snap beetle. The larvæ require from one to six years for their development. All injury is produced by larval feeding.

Control: Difficult; for wet lands thorough liming and tile draining are recommended as beneficial. In sandy soils, liberal addition of humus helps. Sod lands intended for corn should be plowed and thoroughly cultivated during summer previous to planting, where wireworms are troublesome.

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Army worms.—Army worms are caterpillars that appear in fields in enormous numbers. They are the larvæ of medium-sized grayish or brownish moths. The eggs are laid in clusters containing many eggs on plants usually of the grass family. They hatch in 7 to 10 days, and young caterpillars, which develop rapidly, locate on the lower leaves of growing plants. About two weeks after hatching the caterpillars may strip fields and thus attract attention. In another week they prepare to transform, and entering the ground become pupæ. The moths emerge 10 to 14 days later, and usually fly away, depositing their eggs elsewhere. Summers following cool, wet springs are favorable for army worms.

Control: Usually the worms can be controlled by sowing poison bran mash as recommended for grasshoppers over the infested areas. Best results are had by sowing the bait in the late afternoon or evening. Where the worms are feeding on grasses or small grains they may be controlled with arsenate-of-lead spray. For the control of the worms feeding in corn the arsenate of lead should be applied so as to penetrate the throat of the plants. Worms may be trapped by the ditch and post-hole method as described for chinch-bug control.

Corn Insects—*European corn borer.*—A pink or dirty-gray caterpillar that bores in all parts of the stalks and ears of corn. Eggs are laid in clusters on the leaves by a small yellowish moth in the evening or night. Either one or two generations are produced each year. The insect overwinters as a caterpillar in stalks, stubble, or ears. Feeds on many kinds of farm and garden crops or weeds.

Control: Utilize corn as silage where possible. Cut corn close to ground and plow under stubble deeply and cleanly in fall. Burn all waste cornstalks, cobs, and field débris previous to May 1. Clean up barnyards and pigpens in early spring and burn all corn débris before May 1.

Chinch bug.—A little, black and white, foul-smelling bug, overwintering as an adult in bunches of grass and under fallen leaves. It flies to small grains in early spring and lays its eggs on the roots, stems, and behind the lower blades of the plants. Young bugs are red with a white band, afterwards becoming grayish black with white markings. At or near harvest they crawl to growing corn, reach maturity in a short time, and produce another generation before winter. They suck their food, and thus can not be poisoned by arsenical insecticides.

Control: Burn all bunches of wild grass, fallen leaves, and field débris while it is dry during late fall and early winter. Trap bugs while they are crawling from small grains to corn by constructing a ditch that has a smooth, steep side nearest the corn. A line of creosote or road oil run along the brow of the steep side of the ditch will prevent the bugs from crossing. Post holes 18 inches deep, dug in bottom of ditch, from 1 to 4 rods apart, will catch most of the crawling bugs. Flare the holes at edges and keep them dusty, so that bugs can not crawl out. Gas tar or coal tar may be substituted for creosote. In emergencies a plain, dusty furrow with smooth sides and post holes as previously described may prove efficient as a trap. Contact insecticides are efficient where they can reach the bugs.

Western corn root worm.—Slender, small, dirty-white worms boring into the buds of young corn and roots of the older plants. The adult is a small, pale-green beetle slightly more than one-eighth inch long. The beetles are frequently found feeding on the fresh silks.

The eggs are laid in the late summer or early fall in the ground of the cornfield, and the egg stage lasts throughout the winter. There is only one generation in a season, and the insect infests only corn. The most serious injury is in the western part of the main Corn Belt.

Control: A rotation which avoids having two successive crops of corn on the same land is 100 per cent effective.

Sod webworm.—Small, dirty-white to gray caterpillar, living in a silk-lined burrow, mostly underground. It cuts plants off underground or eats out bud or central leaves of plants. Eggs are laid by small moths or millers that rest with their wings curled around their bodies. They live normally in sod lands.

Control: Plow cornlands, especially those freshly broken from sod, in summer or early fall previous to seeding. Where young corn is attacked, allow injured plants to remain, but plant fresh seed rows between original rows of corn. Reseeding in original hills is not recommended.

Corn ear worm.—See Truck-Crop Insects.

Wheat Insects—*Hessian fly.*—A small, dark-colored, mosquitolike insect, laying its eggs on the upper sides of the leaves. Eggs hatch into salmon-colored maggots that locate behind leaf sheaths and suck sap of plants. The red color soon disappears and the maggot becomes white with a greenish tinge. Maggots of the fall generation damage young wheat in the fall, overwinter as "flaxseeds," and in the following spring emerge as flies to lay eggs that produce the new or spring brood of maggots. Where these locate stems become weak and shrunken at point of contact, and plants may fall over and be missed by harvesting machinery. Hessian fly causes shrunken heads and reduced yields. Winter-wheat stubble carries most of the infestation through the summer. Volunteer grain serves to carry over the pest between seasons.

Control: Delay planting winter wheat until the safe date as advised for a specific region by State experiment station, especially during years of serious infestation. Plow under the stubble as soon after harvest as possible in regions where wheat is not seeded to grass; prepare a good seed bed; and destroy all volunteer grain as soon as it appears. Organize entire community for cooperative control. Do not "stubble in" wheat on wheat stubble. Grow a variety of wheat of proven high value for local conditions, and where possible adopt a rotation including one cultivated crop and a legume.

Green bug.—A small, green aphid that sucks the juices of young small grains, turning the blades red or yellow. Overwinters as adult or young aphid on young wheat and oats. Multiplies with extreme rapidity during cool, damp springs. Lives in volunteer oats and wheat during late summer, attacking young winter grain later on.

Control: Destroy all volunteer wheat and oats in midsummer and early fall. Where small patches of green bugs are found in young grain, plow spots under promptly. Seek advice of State extension entomologist.

Wheat sawfly.—Slender, whitish worm living inside stems. It cuts the stem at the ground line about harvest time. Eggs are laid by a dark-colored, slender, wasplike insect in stems. It winters as a worm in wheat stubble and in grass.

Control: Plow under infested stubble thoroughly in late summer or early fall. Cut infested wheat just before it becomes dead ripe, before stems are entirely dry. Rotate crops where practicable.

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Alfalfa Insects—*Alfalfa weevil.*—A green, wormlike grub eating the leaves. Eggs are laid by a brown, hard-shelled snout beetle or weevil chiefly in stems of alfalfa. It overwinters as a beetle in the soil, laying eggs during spring. There is one generation each year in the Northwest.

Control: In the Great Basin spraying once during either May or June is recommended as efficient. Use calcium-arsenate spray or dust. Apply at rate of 100 gallons per acre with a pressure of at least 75 pounds at nozzle. More than one spraying may be required in some localities.

Clover Insects—*Clover-leaf weevil.*—Yellowish or greenish worm with narrow pink line down center of back. It attacks leaves of various clovers and alfalfa. Eggs are laid in the stems by brown, hard-shelled snout beetle. It winters both as adult and larva on or near host plants.

Control: In case of excessive damage, spray crop with arsenate of lead, 2 pounds, to water 50 gallons, common laundry soap 1 pound. Apply 100 gallons per acre.

Clover-flower midge.—Tiny cream or salmon colored maggot eating out substance at base of flowers. Eggs are laid by a gnatlike fly. Two generations are produced each year. Maggots drop to ground in late June and mid-September. They winter as cocoons in the soil.

Control: Cut infested clover in early June before maggots are ready to leave flowers. When maggots change color from cream to pink, cutting should be done immediately. Spring pasturing in northern latitudes is beneficial.

Fruit Insects

General Pests—*Eastern tent caterpillar.*—Tent caterpillars in the spring make unsightly nests in apple and other trees in orchards, along roadsides, and elsewhere. Their favorite food is wild cherry, though the caterpillars feed upon numerous other plants, especially apple. The winter is passed in the egg stage, the eggs being found in masses more or less surrounding the smaller limbs or twigs to which they are firmly glued. The eggs hatch as the buds begin to break in the spring, and the gregarious larvæ start a tent in the crotch of adjacent limbs. As the larvæ grow the tent is increased in size, and often attain a length of 2 feet. When grown the caterpillars desert the trees and wander here and there in search of a place in which to pupate. The moth develops in about three weeks. Eggs are laid on the twigs and hatch the following spring.

Control: See spraying schedules.

San José scale.—A small, circular, grayish, scalelike insect about the size of a pinhead infesting the limbs and branches of apple, peach, pear, plum, currant, and the like. Trees incrusted with the scale have a grayish appearance as if dusted with ashes. The insect overwinters in a half-grown condition, completing growth in the spring when it begins to breed by giving birth to living young. It is very prolific, and because of its short life cycle a number of generations may be produced during a single season. Trees infested from the nursery are usually killed in two or three years.

Control: Spray during the dormant period, preferably in the spring, with lime-sulphur concentrate at the rate of 1 gallon to 7 to 9 gallons of water, or with 2 or 3 per cent lubricating-oil emulsion, or a good miscible oil. Badly infested trees should be severely pruned and stimulated by the use of nitrate of soda to induce new growth.

Apple Insects—*Apple aphids.*—Several kinds of aphids occur on apple foliage, but principally two species are responsible for curling the leaves—the rosy aphis and green aphis, the former also causing small, deformed fruit. These aphids winter on the trees in the egg stage, the eggs hatching early in the spring as the green shoots are pushing through the bud scales. The green aphis continues breeding on the apple throughout the year, but the rosy aphis, after a few generations, migrates from the apple to plantain, returning to the apple in the fall.

Control: See spraying schedule.

Codling moth.—The dirty-white or pinkish caterpillar of the codling moth is the principal cause of worminess of apples in the United States, and infests also pears and sometimes other fruits. In southern California it is a serious pest of walnuts. The insect winters in the larval stage in cocoons under rough bark on the trunk and branches and in cracks in the soil at the bases of trees. Many caterpillars are carried from orchards to packing houses and storage cellars with apples in the fall, where they overwinter in secluded places, the moths escaping to orchards in the spring. There is one, and sometimes from two to four, more or less complete generations each year according to latitude, ranging from about one in Maine and northern New York to three or four in Arkansas and Georgia. In the spring the moths lay their eggs shortly after the falling of the apple blossoms. Many larvæ of the first brood enter the little apples at the calyx end, but the later or summer broods of worms enter more through the side of the apple, producing the so-called "sting."

Control: See spraying schedule.

Round-headed apple-tree borer.—This white, grublike larva infests apple, quince, and other trees at the collar, eating out at first small cavities or patches in the cambium, but later burrowing into the deeper parts of the trees. When full grown the parent or beetle escapes by chewing out a roundish hole from the center of the tree trunk, usually 8 or 10 inches from the ground. About three years are required for the complete life cycle of this borer. It is especially troublesome in orchards in the mountainous districts in the East, where the service berry, mountain ash, and crab occur, which are its native food plants.

Control: Fruit trees subject to attack should be wormed each year, care being taken not to injure the bark or wood more than necessary. Much protection will result from the application to the tree trunks of a paint made from raw linseed oil and pure white lead.

Apple Spraying Schedule—*First application.*—Use concentrated lime-sulphur solution (33° Baumé) at the rate of 1½ gallons to 50 gallons of water plus 1 pound of powdered arsenate of lead, or 2 pounds of arsenate of lead paste just before the blossoms open. This is for apple scab, the plum curculio, cankerworms, the bud moth, case-bearers, and the tent caterpillar. Add about one-half pint of 40 per cent nicotine sulphate if apple red bugs are troublesome and if apple aphids are much in evidence.

Second application.—Use same spray as in first application as soon as the blossoms have fallen. This is for the above-mentioned troubles as well as for the codling moth and leaf spot. It is the most important application for both apple scab and the codling moth. In spraying for the codling moth at this time the aim is to drive into the calyx end of each little apple a quantity of the poison, and, to accomplish this, painstaking work is neces-

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sary. Failure to do thorough spraying at this time for the codling moth can not be remedied by subsequent applications.

Third application.—Use the same spray indicated above, three to four weeks after the blossoms have fallen. This is the second treatment for the codling moth and leaf spot, and gives further protection against apple scab and certain insects. In orchards in which blotch has been prevalent this application should be made not less than three weeks after the blossoms have fallen. Where this disease has been severe Bordeaux mixture (3–4–50) should be substituted for the lime-sulphur solution.

Fourth application.—Use Bordeaux mixture and an arsenical eight to nine weeks after the petals have fallen. This is the first application for the second brood of the codling moth and for bitter rot. In orchards in which bitter rot has been a serious disease this application should be advanced about one week.

Fifth application.—Use Bordeaux mixture from two to three weeks after the fourth application. This is the second application for bitter rot.

Sixth application.—Use Bordeaux mixture again two or three weeks after the fifth treatment has been applied. This is the third application for bitter rot and is ordinarily sufficient to carry the fruit through, but on specially susceptible varieties in bitter-rot sections a treatment to be made two weeks later may be found necessary.

Seventh application.—In severe cases of bitter rot a seventh application may be necessary, and in severe cases of blotch an extra treatment midway between the third and fourth applications is sometimes required.

Note.—In the more northern apple-growing sections the first four applications during ordinary seasons will be sufficient to protect the fruit from various insects and diseases mentioned. In the more central States, where bitter rot and blotch are prevalent, the fifth and sixth applications will be necessary. For summer apples only the first three applications are needed. Omit arsenicals in the fifth and later applications. Any spray residue should be wiped from fruit before marketing.

Peach Insects—*Plum curculio.*—A small snout beetle which punctures for feeding and egg-laying purposes most stone and pome fruits. It is the cause of most knots and deformities in apples in the Mississippi Valley and Eastern States. Its white larva or grub is very common in ripe peaches, apricots, and nectarines. Most plums attacked by the curculio fall before ripening, and the larvæ are unable to develop in apples on the trees. The insect passes the winter in the adult condition, hibernating in trash in and around orchards, and appears in the spring about blossoming time of orchard fruits, feeding more or less on the buds, blossoms, and foliage before the fruit is advanced enough to be attacked. Normally there is but one generation of grubs each year, though in the South in some seasons a second generation may develop. Much of the infested fruit falls to the ground, where the grub completes its growth, later deserting the fruit and entering the ground, where it pupates. The adults emerge in two or three weeks and feed in the orchard the rest of the season until hibernation time.

Control: Apple orchards in sod and surrounded by waste growth are more subject to injury than where clean culture is practiced. Spraying with arsenate of lead, as for the codling moth, materially helps to control this insect under favorable cultural conditions. The insect is effectively controlled on peaches by spraying or dusting

the trees and picking up the fallen, wormy fruit where practicable. (See spraying schedule for apples and peaches.)

Peach borer.—A stout, white, brown-headed caterpillar infesting the bases of peach, cherry, plum, and other stone-fruit trees, eating patches or galleries in the soft bark. Infested trees exude at the collar, especially during damp or rainy weather, a mass of gum, more or less mixed with grass and dirt. The adults are clear-winged moths, the female depositing her eggs from about June to August, according to latitude. These are placed on the trunk, branches, and foliage of the trees or often on weeds and trash on the ground. Larvæ upon hatching make their way to the base of the tree and bore into the soft bark, where they feed until cold weather comes, when they become dormant. In the spring they resume feeding and growth. They are generally full grown by midsummer, when they pupate, the moths emerging two to three weeks later. There is but one breed of larvæ each year.

Control: Carefully worm the trees in the spring and fall of each year. Trees 5 years of age and over should be treated with paradichlorobenzene in the early fall, as follows: Clear an area 12 inches wide around the tree. Drop 1 ounce of the white, crystallic paradichlorobenzene in a narrow band around the trunk 1 to 2 inches distant from the tree. Cover with several shovels of loose earth and pack down smoothly. Uncover the mounds six weeks after application.

Peach Spraying Schedule — *Midseason varieties.* — The midseason varieties of peaches, such as Reeves, Belle, Early Crawford, and Elberta, should be sprayed as follows:

(1) One pound of arsenate of lead powder or 2 pounds of arsenate of lead paste per 50 gallons of water, to which has been added the milk of lime made from slaking 3 or 4 pounds of stone lime, about 10 days after the petals have fallen or at the time the calyces are shedding.

(2) With self-boiled lime-sulphur mixture and arsenate of lead two weeks later, or four to five weeks after the petals have been shed.

(3) With self-boiled lime-sulphur mixture (omitting the arsenical), four or five weeks before the fruit is due to ripen.

Late varieties.—The Salwey, Heath, Bilyeu, and other varieties with a similar ripening period should receive the treatment prescribed above, with an additional application of self-boiled lime-sulphur mixture alone, to be applied three or four weeks after the second application.

Early varieties.—The Greensboro, Carman, Hiley, Mountain Rose, and varieties of the same ripening period should receive the first and second applications only, as prescribed for midseason varieties.

Grape Insects—*Grape leaf hopper.*—A small, agile, whitish insect infesting the lower surface of grape leaves, becoming abundant by midsummer. Both young and adult occur together sucking the sap from the leaves, causing these to become blotched with white, and later to turn brown, many of the leaves falling. This injury interferes with the proper ripening of the fruit and prevents normal vine growth.

Control: See Grape Spraying Schedule.

Grape berry moth.—A small, active, greenish caterpillar about three-eighths inch long. The parent is a small, obscure moth not readily seen by vineyardists. There are two generations of caterpillars each year.

The first attacks the blossom clusters and young berries; the second bores into the fruit during late summer and fall, spoiling the bunches, thus necessitating careful sorting before marketing.

Control: See Grape Spraying Schedule.

Grape Spraying Schedule—*First application.*—About a week before the blossoms have opened or when the shoots have become 12 to 18 inches long, spray with Bordeaux mixture 4–3–50 for fungous diseases, adding 2 to 3 pounds of arsenate of lead paste, or one-half that quantity of the powdered form for the flea beetle, rose chafer, and other insects.

Second application.—Just after the blossoms have fallen spray with the same materials as in the first application for the same fungous diseases and insects and for the grape berry moth, grape leaf folder, and adults of the grape root worm by the "trailer" method.

Third application.—About two weeks later use Bordeaux mixture 4–3–50, powdered arsenate of lead, 1 to 1½ pounds, or 40 per cent nicotine sulphate ¼ pint, to 50 gallons of spray mixture for fungous diseases, berry moth, eight-spotted forester, grape leaf folder, grape vine aphid, grape root worm, and grape leaf hopper. To destroy the leaf hopper direct the spray against the lower surface of the leaves. To control the berry moth thoroughly coat the grape bunches with the spray by the "trailer method."

Fourth application.—About 10 days later, or when the fruit is nearly grown, if black rot or mildew still appears, spray with neutral copper sulphate or verdigris at the rate of 1 pound to 50 gallons of water.

Currant and Gooseberry Insects—*Imported currant worm.*—When full grown the slug or "worm" is about ¾ inch long, green in color, and yellowish at the ends. Younger larvæ are covered with black spots, and the head is black. These slugs attack the foliage of currants and gooseberries shortly after it puts out in the spring, feeding at first in colonies, but later scattering over the plant. Plants are quickly stripped of their leaves, and prompt measures are necessary when the insects are discovered. A second brood of slugs may appear in early summer, and in some regions a partial third brood may develop.

Control: Be on the lookout for the first brood of slugs in the spring, and treat the plants promptly with lead arsenate dusted or sprayed on the foliage. In treating the second brood near ripening time of the fruit, dust hellebore diluted with 5 to 10 parts hydrated lime or flour, or use in a spray 1 ounce to the gallon of water.

Citrus and Subtropical Fruit Insects—*Citrus white fly.*—The adults are small, active, mealy, white insects that congregate abundantly on the lower surface of the younger leaves where they deposit pale yellow, minute, oval eggs. In the immature stages the insects are scalelike, oval, yellowish in color, closely applied to the leaves, and rather inconspicuous. The empty pupal cases on the older leaves are whitish and are therefore easily detected. The insects suck the juices from the leaves and do serious injury in this way. They are more important, however, on account of the honeydew voided on the foliage and fruit on which sooty fungi grow, greatly marring the appearance of the fruit.

Control: Use lubricating-oil emulsion, dilution B, as for purple and red scales in Florida and the Gulf States.

Black scale.—The full-grown females are black, hemispherical, about the size of a split pea, and have an H-like marking on the back. They deposit eggs during

late spring and early summer (sometimes several thousand). At first the young occur principally on the leaves but later on the twigs. The scales as they grow void honeydew, on which sooty fungi grow, discoloring the foliage and fruit. Black scale attacks citrus, olive, and many other plants.

Control: On citrus in California it is controlled principally by fumigation with hydrocyanic-acid gas; on deciduous fruits petroleum sprays are employed. The natural enemies of the scale do much to keep it reduced in some sections of the State. In some important districts this species, and also the California red scale, are very resistant to fumigation. Under these conditions consult the State extension entomologist.

Purple scale.—The female scales resemble miniature oysters in shape, are brown to purplish in color, and when grown are about one-eighth inch long. The eggs are deposited under the parent scale, and larvæ appear in the spring or early summer. These settle on all parts of the host plants. There are several generations each year. The leaves show yellow spots where the scales settle.

Control: In California the full fumigation dosage of hydrocyanic-acid gas is employed, whereas in Florida the scale is controlled with lubricating-oil emulsion, dilution B.

Red scales.—The female scale is large, circular in outline, dark brown, and has a lighter-colored central nipple. This is a very prolific species, and there are three or four generations each year. It is common in greenhouses, infesting a large number of plants, and is a serious pest to citrus in Florida and the Gulf States. A similar species is found in California.

Control: In Florida it is kept under control with lubricating-oil emulsion, dilution B. For control of California red scale see Black scale.

Truck-Crop Insects

General Pests—*Cutworms.*—Small plants cut off at ground level or completely consumed during the night. A search in the soil one-half inch or more below surface at base of destroyed plant discloses grayish, brown, or nearly black worms usually tightly coiled. The mature worm is about 1½ inches in length. The eggs are laid in masses on miscellaneous objects by a moth, measuring about 1½ inches across wings. Forewings are gray to dark, hind wings light. Brown pupæ one-half to three-fourths inch long are found in soil. These insects hibernate as eggs, partially grown worms, or pupæ, depending on the species concerned and locality. From one to several generations are produced annually.

Control: Poisoned bait. Quick action is necessary, as an entire crop may be destroyed in a few days. Bait should be scattered in vicinity of injured plants in evening at the rate of about 10 pounds per acre. Repeat if plant cutting continues. On land known to be infested or on recently turned-under sod land, scatter bait before setting such plants as melon, tomato, and cabbage.

Grasshoppers.—See Cereal and Forage Insects.

Control: Poison bait scattered thinly and evenly over the affected area at the rate of 6 pounds per acre. Repeat if hoppers continue to come into field.

Wireworms.—See Cereal and Forage Insects.

Control: Direct control by soil fumigation is expensive, but carbon bisulphide and calcium cyanide are useful on smaller areas. Many kinds seek sod land for egg laying,

so such land after being broken should be planted to less susceptible crops until the worms have become scarce. Liming and subdraining will partially control some species. On small areas the worms may be reduced by baiting with potatoes and collecting the worms from the soil surrounding the tubers. Crop rotation and early fall or summer plowing are useful where this practice is possible. Some species, principally occurring in the West, deposit eggs in cultivated soil, so continued cultivation alone does not reduce their numbers.

White grubs.—See Cereal and Forage Insects.

Control: Eggs are laid in grassland, so such land after being broken should be planted with nonsusceptible crops until grubs have matured. Potatoes and corn are the most susceptible crops. (Carbon bisulphide is valuable for direct treatment, but expensive.) Fall plowing to destroy insects, and crop rotation are useful, as is clean cultivation to avoid deposition of eggs.

Mole cricket.—Young crops killed and the soil perforated with numerous tunnels. Burlap sacks, to serve as traps, placed on ground in infested areas when lifted will disclose large, shy insects resembling crickets though yellow in color, and with forelegs adapted for digging. These immediately conceal themselves in the soil and are difficult to see or to capture. Eggs are deposited in soil, and the nymphs resemble adults, though smaller and lacking wings. Some plants are eaten, but the principal injury is caused by the tunneling, which destroys rootlets of young plants and causes the soil to dry out.

Control: Poisoned bait made of 10 pounds cottonseed meal, 10 pounds rice flour, and 1 pound calcium arsenate, the mixture moistened with molasses solution, 1 part molasses to 10 parts water, and scattered evenly over affected areas. Two applications should be made two weeks apart. Heavy rains ruin the bait. Effectiveness of bait can be determined by the number of burrows made after treatment.

Seed-corn maggot.—Small white maggots found in germinating seed of beans, corn, and other plants. They are particularly injurious to seed which has been slow to germinate because of unfavorable conditions. The adult resembles the house fly in size and appearance. The eggs are laid in soil, and maggots attack germinating seeds of various plants as well as seed potatoes. About three generations develop annually.

Control: No direct remedy is useful on seeds, since injury is well advanced when symptoms are noted. Organic fertilizers attract flies for egg laying and should be avoided when possible on susceptible crops. Conditions which germinate seeds rapidly and promote rapid plant growth will reduce injury.

Blister beetles.—The foliage and flowers are stripped from the plants by these insects, which feed in swarms and destroy large areas of vegetation in a short time. They move rapidly when disturbed. The beetles have comparatively soft wing covers and are black and brown, marked with light stripes, or wholly black or grey in color, depending upon the species, usually about one-half to three-fourths inch in length. The eggs are deposited in the ground, and the immature forms are predaceous.

Control: Prompt action is necessary. Treat with lead-arsenate spray, using four times the normal quantity of lead arsenate, or dust with calcium (or lead) arsenate, 1 pound of the arsenical to 4 pounds of hydrated lime. Sodium fluosilicate with equal parts hydrated lime shows promise as a remedy.

Slugs and snails.—Slugs and snails feed upon the foliage of many garden plants and are particularly injurious to young seedlings. Their favorite haunts are shaded, damp locations, and as a rule they feed near the ground. The slugs are soft-bodied and not protected by a shell; in color are dark to light gray and vary in length from 1½ to 8 inches when full grown. A thick mucus exudes from and covers the body and adheres to the surface over which the slug crawls. The snail's body is covered by an outer shell attached to the back. When the snail feeds, the mouth and fore part of the body protrude from the shell, and when it is in motion the shell is carried on the back.

Control: Thoroughly clean up infested area by raking and burning. To check injury on growing crops spray with Bordeaux mixture, and distribute poison baits, prepared as follows: Finely chopped lettuce leaves 16 parts, calcium arsenate 1 part; thoroughly mix these ingredients, and place the mixture in small heaps throughout the infested area late in the evening, or bran by weight 16 parts, calcium arsenate 1 part, moisten with water until bran flakes stick together, and scatter thinly late in the evening.

Potato Insects—*Colorado potato beetle.*—Irregular sections of leaf are destroyed, and in severe attacks leaves are stripped from the plant.

The adult is an oval, robust, yellow beetle about one-third inch in length with 10 black stripes. It overwinters as a beetle in the ground and emerges in the spring and lays yellow eggs in clusters on the undersides of potato leaves. The egg hatches in a few days, and the soft-bodied larva is brick red in color, has black head and legs, and is marked with black spots on the sides of the body. As the larva develops it varies in color from red to yellow.

Control: Spray or dust with an arsenical.

Potato aphid.—Plants have unthrifty appearance, upper leaves curled inwards and terminal shoots wilted, brown, or dead. The aphid feeds by sucking the plant juices, working from the undersides of the leaves, and when abundant occurs in masses clustered on the growing tips. The aphid is soft bodied with comparatively long legs, its color varying from shades of green to pink. The winter is passed in the egg stage on rose, and from this plant it migrates to the potato. During the growing season only females develop, and these produce living young very rapidly.

Control: Direct control of this insect is both difficult and expensive. Thorough treatment with nicotine sulplate, spray dilution A, is effective when properly applied. Fungous and insect parasites often effect control, but only after considerable damage has already been done.

Potato leaf hopper.—The adults and immature forms feed by sucking the plant juices, producing a condition known as hopper burn. It first shows as a slight yellowing of the tip of the leaf, and as the disease develops the leaf slowly turns brown, curls upward, and finally dies. During hot, dry weather hopper burn develops rapidly.

The adult is small and pale green, about one-eighth inch long. It flies and hops readily when disturbed. When hatched it is nearly white in color, but turns green as it develops. The nymph moves rapidly over the plant when disturbed. The adults overwinter and migrate to the potato fields from other food plants. The eggs are laid in the tissues of the potato leaf.

Control: Bordeaux mixture controls the leaf hopper and thereby checks hopper burn. Apply thoroughly as

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soon as the leaf hopper appears in the field. Cover all parts of the plant, and repeat applications as often as necessary to keep plants well covered until the crop has matured.

Potato flea beetle.—Leaves of plants are riddled with small holes, and when severely infested the leaves turn brown. The insect is a small, active beetle, about one-twelfth inch long, which hops like a flea when disturbed. The body is black and antennæ and legs are a dull yellow. The insect passes the winter as a beetle under rubbish. The eggs are laid in the soil, and the larvæ feed on roots. The beetle causes the principal injury, and this is more serious during dry seasons, when plant growth is retarded.

Control: Poisoning difficult; best results are obtained by spraying with Bordeaux mixture, 4–4–50, to which lead arsenate is added at the rate of 2 pounds to 50 gallons.

Tomato Insects—*Tomato worm.*—Tomato plants showing branches with all leaves eaten. Careful search shows a heavy green worm about 3 inches long with white side markings and a prominent horn on back near hind end of body. It develops from yellowish eggs laid singly on the tomato plant. The worms defoliate the plants rapidly. The adult is a hawk moth with wing expanse of about 4½ inches, found in evening around flowers. The insect overwinters in the soil as a brown pupa about 2 inches long.

Control: Apply lead arsenate spray or lead arsenate dust. For light infestations hand-pick worms, which may be readily located near the defoliated areas of the plants.

Aphids.—See Potato.

Tomato fruit worm.—For description of pest see Corn ear worm. Worms feed on tomato foliage sparingly and cause principal damage by eating holes in tomatoes, which are often followed by various rots.

Control: Poisoning is only partially effective, as it is too difficult to keep the developing fruit covered with poison. Several treatments with lead arsenate are useful. Poison bran bait scattered over the plants as used for cutworms is suggested.

Flea beetles.—See Potato flea beetle.

Cucumber and Melon Insects—*Melon aphid.*—Injured melon vines have curled leaves, distorted tips, and a sooty appearance. Such plants are often sticky with honeydew. Aphids varying in color from green to black occur in large numbers inside the curled leaves and on the undersides of other leaves. The insects occur in colonies, and if not checked soon spread over the whole field.

Control: Treatment should begin before the leaves curl, when the aphids may be effectively reached with the insecticide. Dusting with nicotine dust is the best control, but the insect may also be controlled if sprayed with nicotine sulphate, dilution B, care being taken to wet the insects. Repeat treatment when the numbers of the aphids again become threatening.

Squash bug.—This insect is commonly known as the stink bug. The adult bug is about five-eighths inch long and dusky brown, with black markings below. The brown eggs are laid in clusters on the undersides of leaves. The nymphs resemble the adults but lack wings. Nymphs and adults feed by sucking juices from plants, causing leaves to curl, to wilt, and finally to die. The plants are stunted or killed. Winter is passed as the adult in rubbish. One generation occurs annually.

Control: The insect is very resistant to insecticides. Some control is possible by spraying with nicotine sul-

phate, 1 pint to 50 gallons of water, with addition of 4 pounds laundry or fish-oil soap. Hand picking of insects and destruction of egg masses are useful, as is trapping of adults under small pieces of board placed near the vines. Clean culture and destruction of vines after harvest should be practiced consistently.

Melon and pickle worms.—Injured melons show holes with frass accumulations. White worms about three-fourths inch in length, striped or spotted with black, are found within the melons. The eggs are laid on tender foliage or blossoms by moths having fore wings with white centers and iridescent brown border. The wing expanse measures about 1⅛ inches. The larvæ feed for a short time on the foliage before entering the melons or cucumbers. Hibernation occurs as pupa. Three or four generations are produced annually.

Control: Direct treatment is difficult and must be applied before the worms enter the melons. Apply lead-arsenate spray, or lead-arsenate dust before signs of injury are noted on the melons. Clean culture to reduce the numbers of the insect is important; and trap crops, using squash planted at varying times to attract the egg-laying moths are useful, but flowers and immature fruit of trap crops must be destroyed when infested.

Striped cucumber beetle.—Small, active, yellow beetle with three black stripes on back. The beetle is about one-fourth inch long. (This insect must not be confused with a somewhat similar insect on potato.) The beetle eats irregularly shaped holes in the leaves, stems, and fruit, and is especially destructive to seedlings. It hibernates as a beetle. The eggs are laid in soil, and the white, wormlike larvæ feed on roots. One or two generations are produced annually.

Control: On seedling melons a careful and timely dusting with nicotine dust at the rate of 20 pounds per acre will protect the plants. A close watch should be kept on seedling plants, since the insect can destroy whole plantings in a short time. On larger plants either use this formula or treat with dust containing 1 part calcium arsenate to 20 parts of gypsum. Several applications may be necessary.

Squash borer.—Vines have wilted appearance, and examination at base of the plant shows frass exuding from small holes in the main stem. Opening of the stem discloses a borer which when full grown is about 1 inch in length, robust, creamy white in color, with black head. The eggs are deposited on the stems of the plant by a moth with a wing expanse of about 1 inch; the front wings are nearly black in color; hind wings transparent. The body is marked with red or orange; the hind legs are long and are covered with red or orange, black, and white hairs. The insect overwinters in a cocoon just beneath the surface of the ground near the plants on which it has fed.

Control: For small plantings slitting the stem, killing the worms, and covering the wound made by the knife with soil is effective. For large areas, destruction of the plants after harvest, followed by fall plowing to destroy stages in the soil, will give partial relief for the following year.

Bean Insects—*Mexican bean beetle.*—Indications of the presence of this pest are injured leaves with a whitened and dried-out appearance. It is a copper-colored beetle with 16 black spots on back. Spine-covered yellow grubs and yellow egg masses are present on undersides of leaves. Adults are one-fourth inch long, grubs one-third inch long. Yellow pupæ are found on undersides of

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leaves of bean and weeds. Adults and grubs eat undersurface of leaves, which die, turn white, and later drop from plants. The yield is reduced or the plants killed. Two to four generations are produced a year, the adult hibernating under leaf accumulations in woodland.

Control: Spray or dust with arsenicals, using any one of the following formulas, and taking care to direct the insecticide to the undersides of leaves. Use high-grade materials low in soluble arsenic, and repeat as necessary. Two to four treatments generally are required.

Insecticide formulas for control of Mexican bean beetle:

Spray: (1) Calcium arsenate, ¾ pound; hydrated lime, 1½ pounds; water, 50 gallons.

(2) Magnesium arsenate, 2 pounds; water, 100 gallons.

(Use sprays at the rate of 90 to 100 gallons per acre.)

Dust: (1) Calcium arsenate, 1 part; hydrated lime, 9 parts.

(Apply at the rate of 15 to 20 pounds per acre.)

(2) Calcium arsenate, 1 part; dusting sulphur, 1 part; hydrated lime, 4 parts.

(Apply at the rate of 12 to 15 pounds per acre.)

(3) Magnesium arsenate, 1 part; hydrated lime, 5 parts.

(Apply at the rate of 12 to 15 pounds per acre.)

Bean leaf beetle.—Round holes are eaten in bean leaves, and in severe cases little is left except the veins. This is a yellow to reddish beetle about one-fourth inch long with variable black markings, generally including four black areas on back. The head is black. The insects hide under leaves and are not generally noticed while feeding. Eggs are laid in soil, and larvæ feed on roots or underground stem or plant. The heaviest injury is done by adults and generally to young bean plants. One or two generations are produced in a year, hibernating as adults.

Control: Spray or dust as for the Mexican bean beetle.

Bean leaf hopper.—(See Potato leaf hopper.) Bean leaves have brown edges, hooper burn, and show curling. A small, active, green leaf hopper is present.

Control: (See Potato leaf hopper.)

Corn ear worm.—(See Corn Insects.) The green or dark-colored worm may enter the pod and destroy the contents or injure it by cutting small holes in the shell. The actual damage to the market product is not usually great, but when attacking beans grown for cannery purposes the worm is liable to gain access to the canned product, thereby rendering it unsalable. For description of insect see Corn ear worm.

Control: In fall plow infested fields.

Cabbage Insects—*Cabbage maggot.*—Cabbage plants showing injury wilt in the heat of the day and have an unhealthy appearance, later dying. The roots and main stalk just below the surface are injured by white maggots that measure about one-fourth to one-third inch in length. The eggs are laid in the soil at the base of the plant by a fly resembling the common house fly, but smaller. On hatching, the maggots feed on the rootlets, later entering the main stalk, and greatly weaken or kill the plant. The pupa is brown and about the size of a wheat grain. Two to four generations occur annually, the insect hibernating as the pupa.

Control: Dissolve 1 ounce corrosive sublimate in 8 gallons of water. Apply about ¼ pint (½ cupful) of the solution to each plant by means of a watering can with

sprinkler removed, or with a dipper and bucket. The first application should be made two or three days after the plants are set in the field; the second about 8 to 10 days later. Plants in the seed bed can be protected in like manner by pouring the solution along the rows. Corrosive sublimate is highly poisonous. Because of its corrosive properties solutions of it should not be prepared in or left standing in metal containers. Protect seedling beds by screening with cloth.

Cabbage aphid.—This aphid feeds on the under and inner surfaces of the leaves in dense colonies, extracting the plant juices, and causing the leaves to curl and to turn yellow. It is a soft, louselike insect, the body covered with a white, waxy secretion. It overwinters in the egg stage, and from the egg the female develops and gives birth to living young. Winged forms are produced which migrate and start new colonies.

Control: Apply nicotine dust at the rate of about 50 pounds per acre, or spray with nicotine sulphate, dilution B, adding 2 pounds of soap to 50 gallons. The waxy secretion and the dense masses in which this aphid feeds make it difficult to reach with a spray, and several applications are essential for complete control.

Cabbage worm.—Velvety green worms about 1¼ inches long are found on cabbages which show injured leaves and holes bored into the head. The eggs are laid singly on cabbage leaves by the white butterfly which is commonly seen flying over cabbage fields. The eggs hatch in 6 to 10 days, and the worms mature in two weeks, changing to green or slate-colored pupæ or chrysalids fastened to a leaf or other sheltered location by a silk loop. Two to four generations are produced annually.

Control: Apply calcium arsenate or lead arsenate as a spray, or dust before the worms enter the head. To the spray add 2 pounds of hard or resin soap to each 50 gallons to spread the material on the smooth cabbage leaf. Dusting is best done while the dew is on the plant. Where cabbage is used as greens, arsenicals are not recommended, nor should these be applied when the cabbage head is well formed. Hand-picking is of value in gardens.

Cabbage looper.—Holes are eaten in cabbage leaves, or sections of leaves are consumed, by a smooth, green worm marked with white, longitudinal lines, which is about 1¼ inches long when mature. In moving the worm "loops" or raises the middle section of its body. The pale eggs are laid singly on the leaves by a dark-colored moth with a wing expanse of about 1½ inches. A conspicuous silver spot occurs near the center of each mottled fore wing. The hind wings are slightly lighter. The worms complete growth and change to pupæ in two to four weeks. The brown pupa is found in a lightly constructed cocoon on the undersides of leaves or near-by objects. Three to five generations are produced annually. It overwinters as a pupa.

Control: (See Cabbage worm.)

Harlequin cabbage bug.—The mature and immature forms of the harlequin cabbage or calico bug suck the juices from the leaves of the plant, the injury first showing as yellow spots, but as feeding continues the leaf and the whole plant turn yellow and finally die.

The adult bug is about three-eighths inch long, half as wide, and brightly colored with black, yellow, and red. Gray eggs banded with black are laid in small masses on underside of leaf. Young nymphs are largely black, but with green, red, or yellow markings. It hibernates as an adult under rubbish.

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Control: (Adults and nymphs are very resistant to contact insecticides.) Clean culture by destruction of cabbage stalks, wild mustard, and other hibernation quarters is the best control. Trap crops of kale, horseradish, and the like attract adults in spring, where they may be destroyed by applications of kerosene.

Pea Insects—*Pea aphid.*—A slender, long-legged, green aphid. Overwinters both as egg and adult female on clover, alfalfa, and other legumes. Migrates in spring to cultivated peas and is most injurious to that crop. Alfalfa also has been seriously injured during springs that are unfavorable to rapid plant growth.

Control: For peas planted in rows spray with nicotine sulphate, dilution B, directing the spray on terminal buds and undersides of leaves, or apply with nicotine dust at the rate of 50 to 60 pounds of dust per acre when temperature is above 70° F. and foliage dry. Timely applications are essential. Make first application as soon as 20 or 30 aphids appear to 1 foot of pea row. For peas sown for cannery purposes consult the State extension entomologist or Bureau of Entomology, United States Department of Agriculture.

Miscellaneous Truck-Crop Insects—*Corn ear worm.*—Corn ears with one or more large green or dark worms near the silk end. On young corn the worms of the early generation bore into the developing stalk. The worm hatches from white, spherical eggs laid on the developing silk near the husk. On hatching, the larva enters the ear and feeds until mature, when it leaves the ear and pupates in soil. The pupa is brown, and three-fourths inch long. The moth has light buff fore wings and white hind wings, the wing expanse measuring 1½ inches. It hibernates as a pupa at a depth of 4 to 6 inches. Two to four generations develop annually.

Control on corn: Fair control on sweet corn is obtainable by dusting the fresh silks with lead arsenate, 2 parts to 1 part flowers of sulphur. The pupæ are reduced in numbers by fall plowing. Of field corn, plant prolific varieties best suited to local conditions. Strains bearing tightly closed ears probably are least injured by this pest. Late corn is usually more severely injured.

Southern Field-Crop Insects

Cotton Insects—*Boll weevil.*—Adult about one-fourth inch long, including snout. Color light yellow to nearly black, depending on age. Adults overwinter in débris of any kind left in fields or adjoining woods, or in Spanish moss. As soon as squares appear upon the cotton plant the female weevil lays eggs in them, which hatch into footless grubs that feed and grow inside the square. In about three weeks the grubs have transformed to the adult stage of the first generation, all changes having been made within the square. In the meantime the square has, in most cases, fallen to the ground. The young adult emerges from the square and is soon ready to deposit eggs for the second generation. Other generations follow during the summer.

Control: If weevils are numerous before squares form, make one application of either dry calcium arsenate or molasses-calcium arsenate mixture (1 gallon molasses, 1 gallon water, 1 pound calcium arsenate). If the mixture is used it should be applied only to terminal buds. Regular dusting operations with dry calcium arsenate should begin when 10 per cent of squares are infested and continue until the weevils are under control. This usually requires three or four applications, every four days, at

the rate of 5 pounds per acre. Then stop until weevils again become abundant. If heavy rains fall within 24 hours after the dusting, repeat application immediately.

Cotton leaf worm.—Adult is a tawny moth with a wing expanse of slightly more than an inch. Larvæ are elongate, somewhat variable in coloring, some being yellowish green with prominent stripes, and others having a black stripe down the back and a fine central yellow stripe. The eggs are laid singly on the cotton leaves. Sometimes the plants are completely defoliated. When full grown the larva webs one or two leaves together to form a cocoon and pupates therein, hanging the pupa by a thread to the stem. The number of generations within the United States varies according to the time of year the first moths reach our borders. The species does not live over winter in the United States, but migrates each year from the regions to the south.

Control: Dust with undiluted calcium arsenate at the rate of 3 pounds per acre.

Boll worm.—See Corn ear worm under Truck-Crop Insects.

Control: Poison as for cotton leaf worm. Fall and winter plowing.

Cotton aphid.—See Melon aphid.

Control: Fall and winter plowing to destroy them upon their weed host plants. Spray with nicotine sulphate, dilution B.

Cotton red spider.—This mite attacks the undersides of the cotton leaves by sucking the juices, causing the leaves to turn red and finally killing the plants. It is hardly visible to the naked eye, and has the appearance of a tiny, blood-red spot, though the color varies somewhat. The winter is passed in the adult stage, largely on wild host plants. In the spring eggs are laid, and generations follow one another with great rapidity.

Control: Destroy all weed growth and such cultivated plants as are found to harbor red spiders during the winter. When a cotton field is threatened, kerosene emulsion, dilution A, is effective.

Tobacco Insects—*Tobacco worms.*—The larvæ bear upon the tail a rather stout, curved horn. These species pass the winter in the ground in the pupal stage. They begin to emerge as strong-winged moths about June 1, and in a few days these moths deposit eggs on the tobacco. There are two generations a year. The larvæ eat ravenously and destroy a vast amount of tobacco if not controlled.

Control: Dust with undiluted lead arsenate when there is no breeze and when dew is on the plants, using 3½ to 5 pounds per acre.

Tobacco bud worm.—The adult is a greenish moth with a wing spread of about 1½ inches. The winter is passed in the pupal stage in the ground. The moths emerge early enough in the spring to infest tobacco-seed beds. The average length of the life cycle is about 38 days. Eggs and larvæ are present in tobacco fields throughout the growing season.

The eggs are laid on the leaves. The young larvæ soon after hatching make their way to the terminal buds of the plants, where they feed upon the unfolding leaves, perforating them and making them unsuitable for cigar wrappers.

Control: Apply lead arsenate and corn meal (1 pound lead arsenate to 75 pounds of meal) to the buds. Continue applications twice a week until the plants are topped.

Tobacco flea beetle.—A small, dark-brown beetle about one-sixteenth inch in length, which hops like a flea. The

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winter is passed in the adult stage. Eggs are deposited in the soil near tobacco plants, and the larval and pupal stages occur underground. There are three generations per year. Adults injure the tobacco by eating small, irregular holes in the leaves:

Control: For Florida conditions use a light application of Paris green to plants. For dark fire-cured tobacco districts of Kentucky and Tennessee poison seed beds with a mixture of Paris green and arsenate of lead (1 pound Paris green to 5 pounds arsenate of lead) at the rate of one-half pound per 100 square yards; on tobacco one-half grown or larger use the same mixture at the rate of 4 to 6 pounds per acre. This mixture will also control horn worms.

Green June beetle.—The larva, which resembles a white grub, has the peculiar habit of crawling on its back when placed on a level surface. The adult is a fairly large, green beetle which emerges in June. Eggs are deposited underground, and the larvæ hatching from them remain in the soil till the following spring. It is at this time that severe damage is done to tobacco-plant beds by the burrowing of the larvæ through the soil. The young, tender plants are uprooted and many of them covered with dirt.

Control: Burn the plant bed in a new place each year. Cover plant beds after September 1. In the fall dust surface of soil with Paris green at the rate of 1 pound to 100 square yards of bed. Poisoned bran bait, dry, broadcast at the rate of 10 to 12 pounds per 100 square yards of bed, is a good control measure in the spring.

Cutworms.—See Truck-Crop Insects.

Control: Use a poisoned bait. In moderate infestations the bait should be applied to the hill at the rate of 10 pounds (dry weight) per acre. It is best to apply the bait in the evening.

Sugar-Cane Insects—*Sugar-cane borer.*—The larvæ are of a pale color, with black spots on the back. The adult is a straw-colored moth with an average wing expanse of about 1 inch. The female adult lays eggs on the cane leaves. These soon hatch and the larvæ work their way to the terminal bud of the plant. Later they crawl down between the stalk and leaf sheaths and bore into the stalk. Pupation takes place within the stalk. There are several generations a year.

Control: Leaves and scraps of cane left on the fields after the cane is cut should be covered lightly with earth in the fall and plowed under in the spring. This practice allows the parasites to winter over successfully and attack the borers the next season. Do not burn leaves or trash after grinding, as this kills the egg parasites. Plant cane free of borers, or immerse the seed cane for fall planting for 20 minutes in water at 122° F. Destroy heavy grasses near cane fields. Have cane fields separated from cornfields.

Sugar-cane mealy bug.—Small, soft-bodied insects covered with a whitish, powdery secretion, occurring in clusters. The eggs are inclosed in white, woolly material. The nymphs hatch from the eggs in warm weather in about four days. The injury to cane is caused by the mealy bugs sucking the juices of the plant.

Control: Control of the Argentine ant will usually control the mealy bug, as the latter does not usually survive in great numbers without the protection of the ant. The Argentine ant may be controlled by a poison sirup made as follows: Granulated sugar, 18 pounds; water, 18 pounds (pints); tartaric acid (crystallized), 12 grams; benzoate of soda, 16.8 grams. Bring the ingredients to

a boil and boil slowly for 30 minutes, then allow to cool. Next, thoroughly dissolve 30 grams of sodium arsenite (pure) in 1 pint of hot water, cool, and add to the cooled sirup. Add also 2½ pounds of good honey and mix thoroughly. For small quantities use the formula: 29 ounces sugar, 29 fluid ounces water, 1.2 grams tartaric acid, 1.7 grams benzoate of soda; 3 grams sodium arsenite dissolved in 3 fluid ounces hot water and add one-fourth pound honey. This mixture should be put in tin cans and attached to stakes or other secure places over the affected fields.

Rice Insects—*Rice water weevil.*—A small gray to brown weevil. The larva is elongate, and pure white in color. Eggs are laid in rows in rice roots under water. Upon hatching the larvæ feed upon the roots until mature. Pupation takes place in a silken sac surrounded by an oval, earthen cell. The adult stage is reached in about 38 days.

Control: Drain water from rice fields about three weeks after the first flooding, and keep the water off for two weeks.

Greenhouse Insects

General Pests—*Aphids*—Greenhouse aphids may be white, green, red, or black in color. They are inactive, and feed in clusters on new growth, at the base of buds, and under the leaves. As a result of their feeding the leaves become stunted, and curl, disfiguring the plants. The honeydew which they excrete ruins the commercial value of plants attacked. Bluish-green root aphids sometimes attack the roots of asters, causing serious injury.

Control: Fumigate with hydrocyanic-acid gas (one-half ounce sodium cyanide per 1,000 cubic feet of space) or calcium cyanide. Spray with nicotine sulphate, dilution A. For root aphids use carbon bisulphide or fresh tobacco dust worked into the soil.

Mealy bugs.—Soft-bodied, elongate, oval insects about one-fifth inch long, covered with a white, mealy secretion and having waxy, taillike filaments on the body margin. Eggs are laid in masses in a waxlike webbing or secretion under the tip of the abdomen. The young resemble the adults, and all stages may be present at one time. They feed by sucking the plant juices on the undersides of leaves, along veins and ribs, and in crevices at base of petioles. Practically all greenhouse plants are attacked, especially coleus, croton, and gardenia. They are usually attended by ants.

Control: Syringe with clear water under pressure as for red spider. Spray frequently with fish oil or other soap solutions. Fumigate tougher plants several times at weekly intervals with hydrocyanic-acid gas (1 to 1½ ounces sodium cyanide per 1,000 cubic feet of space) or calcium cyanide. Use poison-sirup bait to control the ants.

Thrips.—Thrips are minute, slender, active, yellowish to blackish insects about one twenty-fifth inch long. They suck the plant juices and void a reddish fluid, disfiguring the foliage, especially of crotons, and discoloring the blooms of carnation, rose, cyclamen, and chrysanthemum. The small white wingless larvæ hatch from microscopic colorless eggs deposited in the leaf tissue. They feed for several weeks before becoming full grown and pupating. Many generations may develop each year under greenhouse conditions.

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Control: Fumigate with hydrocyanic-acid gas, using one-fourth to one-half ounce sodium cyanide per 1,000 cubic feet of space three or four times at weekly intervals, or with calcium cyanide, or with tobacco smudges. Spray with nicotine-soap solution or dust the foliage with very fine tobacco or nicotine dust.

White fly.—The greenhouse white fly is one-sixteenth inch long, has four wings and a white, floury appearance. It attacks such plants as calendula, ageratum, primula, coleus, lantana, golden glow, and geranium. It sucks the juices from the leaves, causing them to turn yellow or brown, and eventually to die. Honeydew excreted by the larvæ and pupæ gives the leaves a glazed appearance and furnishes an excellent medium for the development of sooty fungus. Minute eggs are deposited on the tender growth, where they hatch in 10 to 12 days. The entire stage from egg to adult requires about five weeks.

Control: Fumigate three or four times at intervals of 10 days or 2 weeks with hydrocyanic-acid gas, using one-fourth ounce sodium cyanide to 1,000 cubic feet of space, the exposure lasting one hour, or use calcium cyanide. Spray with fish-oil soap solution or with a 40 per cent nicotine-sulphate solution, dilution A.

Cutworms.—(See Truck-Crop Insects.) Cutworms are destructive to marigold, rose, sweet pea, chrysanthemum, carnation, asparagus, violet, smilax, and other plants. In the spring and summer they attack the flower buds, causing severe injury in a short time. Sometimes they cut off plants at the surface of the ground. The larvæ become full grown in about four weeks and pupate in the soil, the night-flying moths emerging 15 or 20 days later.

Control: Poison-bran mash.

Caterpillars.—Several species of caterpillar, exclusive of cutworms, are frequently transient enemies of greenhouse plants, including chrysanthemum, carnation, cineraria, smilax, geranium, calendula, and rose. They injure the plants by chewing and feeding on the foliage, buds, and stems. The cabbage looper and "woolly bears" are the worst offenders.

Control: For the cabbage looper, spray or dust with arsenate of lead when heavily infested, or collect and destroy.

The yellow woolly-bear caterpillar is 2 inches long and characteristically ornamented with many long hairs which are usually pale yellow, brownish, or fox red. It is usually prevalent during July and August. It overwinters in cocoons under loose shelter.

Control: Spray or dust with arsenate of lead or collect and destroy caterpillars and cocoons.

Leaf tyers and leaf rollers.—Usually small, active, green caterpillars not over one-half inch long, which roll, fold, or tie the leaves upon which they feed. They injure chrysanthemum, cineraria, rose, carnation, geranium, and snapdragon.

Control: Collect and burn infested leaves. Spray with lead arsenate, or dust with a dry mixture consisting of lead arsenate 1 part and fine dusting sulphur 9 parts.

Red spider.—This mite which is only one-fiftieth inch long is so small that it may not be discovered until it has disfigured the plants. It feeds on rose, violet, sweet pea, carnation, chrysanthemum, and other plants. By puncturing the under surfaces of the leaves and sucking the plant juices it causes them to turn yellow, to shrivel, or to drop. The web which it spins is also unsightly. After hatching, the mites become full grown

in a week and lay eggs for the next generation. They thrive where plants are grown on sandy soil, or in a hot, dry atmosphere.

Control: Syringe with clear water under 25 pounds pressure where this can be done without injury to the plants. Dust frequently with very fine sulphur.

Scale insects (hard and soft).—Hard scales: These are very small and flat, circular or elongate in outline, and protected by an easily detached waxy scale or covering. They have a scurvy or oyster-shell-like appearance and are white, brown, or gray. They usually occur in clusters incrusting the parts attacked. They move about only when just hatched from the eggs and soon settle down, insert their beaks into the plant tissue, and develop to adults, which secrete an armored scale covering. Found on palms, ferns, croton, orchid, rose, and other plants.

Soft scales: Usually brownish, turtle-shaped insects, about one-fifth inch long, soft, and easily crushed. The upper surface of the female gradually hardens and eventually forms a scale cover under which eggs are laid. The insects occur on ferns, croton, and various greenhouse plants.

Control: Cut out and burn badly infested parts. Fumigate frequently with a greenhouse dosage of hydrocyanic-acid gas or calcium cyanide, or spray with soap solution, 1 pound to 4 gallons of water.

Rose Insects Under Glass—*Rose midge*.—Roses become distorted, turn brown, and die. The adult is a fragile, two-winged fly, one-sixteenth inch long, yellowish with a brown head, which lays eggs in the succulent growth. The maggots feed at base of flowers, buds, and other tender growth, causing them to die. An infested bud may contain 20 to 30 tiny maggots which reach maturity in about a week. They drop to the ground and pupate in the soil, the adults emerging about five to seven days later. The life cycle is completed in 12 to 16 days. Infestation is serious from May to July, and October to November.

Control: Pinch back all infested growth, then fumigate with (*a*) hydrocyanic-acid gas, using one-fourth ounce sodium cyanide per 1,000 cubic feet, or (*b*) calcium cyanide, or (*c*) tobacco smudge, until the midge is controlled. Spread tobacco dust one-fourth inch thick on soil of beds in April and September. Spray walks and under benches with 5 per cent kerosene emulsion to kill those in the soil.

Strawberry root worm on roses.—A small, brown, shiny beetle with four darker spots on its back. These beetles "play possum" when disturbed. They feed mostly at night on the foliage, blossoms, buds, and stems of roses. The larvæ feed on the roots. The eggs are laid in the dead and dried leaves. From these hatch larvæ which enter the soil and develop to pupæ and adults. Larval feeding causes stunted growth and sickly plants. Beetles are injurious and riddle the foliage with holes in May, June, and July, and again in September and October.

Control: Persistent control program necessary. To kill the beetles fumigate two or three times at intervals of three days with hydrocyanic-acid gas, 2 ounces sodium cyanide per 1,000 cubic feet, one hour exposure, when plants are to be cut back and dried during June to September. Dust foliage with a mixture of lead arsenate or calcium arsenate (15 lbs.) and very fine sulphur (85 lbs.) during growing season. Collect and burn dead leaves and débris every two weeks, to prevent eggs from hatching and larvæ from entering the soil.

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Chrysanthemum Insects Under Glass—*Chrysanthemum midge or gall fly.*—Small, cone-shaped galls are formed by the larvæ of a fragile, two-winged fly one-fourteenth inch long, with yellowish or reddish-orange body. The flies emerge after midnight and lay eggs during the early morning. The larvæ which hatch from the eggs bore into plant tissue, and cause the galls. These galls, within which the larvæ and pupæ develop, render the foliage and buds unsightly for commercial purposes, and ruin the central stem. The whole life cycle requires about six weeks.

Control: Fumigate, after midnight, with hydrocyanic-acid gas, or calcium cyanide, or tobacco, nightly for 4 to 6 weeks to kill the flies; or spray with nicotine sulphate, dilution A, every three or four days, to control the flies as they emerge from the galls.

Ornamental-Plant Insects

General Pests—*Blister beetle.*—Blister beetles (see Truck-Crop Insects) feed voraciously on the foliage of such plants as aster, chrysanthemum, calendula, dahlia, gladiolus, and verbena.

Control: Spray with lead arsenate or Paris green, or dust with a mixture consisting of equal parts of sodium fluosilicate and hydrated lime. Where only a few plants are concerned, hand-picking is effective. Choice plants may be protected if screened with mosquito netting.

MAN AND DOMESTIC-ANIMAL PESTS

Insects Affecting Man

Mosquitoes.—Mosquito eggs are laid in masses on the surface of water. The larval and pupal stages are passed in the water. The length of the life cycle varies from a few days to three or four weeks, depending upon the temperature.

Control: Drain breeding places or spray them with sufficient oil to maintain a surface film. "Top minnows" placed in standing bodies of water are sometimes effective if weeds and grasses growing in the water are eliminated. Dusting breeding places with Paris green is helpful in controlling species the larvæ of which feed at the surface of the water (malarial mosquitoes).

House Fly.—The eggs are laid in masses in fermenting vegetable matter, usually fresh horse manure. They hatch in about 24 hours, and the larvæ feed and grow in the material in which the eggs are laid. Pupation usually takes place around the edges of the manure pile; sometimes in the adjacent soil. Length of the life cycle in midsummer is about 10 days.

Control: Treatment of breeding places with powdered borax at the rate of two-thirds pound borax to 8 bushels of manure is effective in destroying larvæ. After borax is applied to the surface of the manure, it should be thoroughly wet down with water. Storage of manure in fly-tight bins until it can be spread thinly over the soil will prevent fly breeding. Sticky fly-paper and traps may be used for the control of adult flies. A very effective fly poison may be made by the addition of 3 teaspoonfuls of commercial formalin to a pint of milk or water sweetened with a little brown sugar.

Bedbug.—Control: Fumigation of room or house with hydrocyanic-acid gas is generally recommended. Sulphur-dioxide gas is recommended as the second-best fumigant. Superheating houses in midsummer to a temperature of 120° to 130° F., is one of the simplest means of eradication. The old-fashioned household remedies, such as a liberal application of benzine or kerosene with small brush or feather or by injecting with syringe into all crevices of beds and furniture and between baseboards and walls where insects are concealed, are also effective. Corrosive sublimate, turpentine, or hot water may be used in the same way as kerosene when they will not injure furnishings. Make a daily inspection of beds and bed furnishings, the seams and tufting of mattresses, and of all crevices.

Body Louse.—An elongate, wingless insect with fleshy beak. The eggs are laid on the hairs of the body or in clothing on the body. They hatch in 5 to 16 days under normal conditions, but low temperatures will prolong the incubation period. The entire life cycle may be as short as 16 days.

Control: Remove all clothing, and bathe all parts of the body, using liquid kerosene-soap emulsion made by boiling 1 part soap chips in 4 parts of water and then adding 2 parts kerosene. An entire change of clothing should be made, and the discarded clothing should be boiled for 20 minutes or run through the regular steam-laundry processes. Infested bedclothes should receive similar treatment.

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Head Louse—Sometimes considered the same species as the body louse. The eggs are laid on the hairs of the head. The head louse has been carried through its entire life cycle in 17 days.

Control: (1) Wash head with equal parts of kerosene and vinegar or 25 per cent acetic acid. Then keep head covered with a towel for one-half hour. Use a fine-toothed comb to remove the eggs and lice. Wash the head with warm water and soap containing kerosene (naphtha soap). Or, (2) anoint head with a mixture of equal parts of kerosene and olive oil, wrap the head in a towel, and sleep in it. Apply vinegar and remove eggs with a fine-toothed comb, then wash out with warm water and soap. Repeat for two or three nights if necessary.

Pubic Louse.—Similar to head louse and body louse. This species is confined usually to the hairy parts of the body, including the head and eyebrows. The eggs are attached to the hairs, and the lice remain fixed to the body with the head imbedded.

Control: The infested person should bathe in hot water, and use an insecticidal soap, such as that described under "Body louse," and then anoint the affected parts with (*a*) yellow oxide of mercury ointment, or (*b*) mercurial ointment (blue ointment), or (*c*) carbolic acid 2 per cent followed by olive oil.

Chiggers.—Minute red mites called "red bugs" in some sections of the country. They occur at or near the surface of the ground and crawl upon persons frequenting their habitat. They bury the mouth parts in the skin, causing considerable pain and discomfort.

Control: Clear out underbrush in breeding places and make a liberal application of sulphur to surface of soil. Application of sulphur to underwear, especially below the waistline, usually gives good results. Bathing in soapy water immediately after exposure is very beneficial.

Cattle Pests

Cattle Grub or Heel Fly.—Swellings about 1 inch in diameter along the back of cattle caused by cattle grub or heel fly. The adult is a robust fly clothed with long yellowish or reddish hairs. The eggs are attached to the hairs of the heel or leg of the cow. Upon hatching the young grubs bore through the skin and work their way up the leg. After considerable wandering about in the body of the host the grub finally takes up a position under the skin near the backbone. A hole is cut through the skin for breathing purposes, and the grub remains just underneath this hole until growth is completed. It then crawls out through the hole and pupates on the ground or under trash. The pupal stage lasts from 30 to 60 days. The adult fly then emerges to lay eggs for another generation. The winter is passed in the larval stage within the host.

Control: Squeeze the grubs out and destroy them during the winter and early spring or press into the grub holes an ointment made by thorough mixture of 1 part iodoform with 5 parts vaseline. The latter method kills the grubs without injuring the animal.

Screw Worm.—The larva of the screw worm is a whitish maggot with minute spines and humps on the body. The adult is a fly considerably larger than the house fly and of a dark bluish-green color, having three distinct black stripes on back between the wings. The face is yellowish red. Eggs are deposited upon dead animals or in the wounds of living animals. Larvæ hatching from the eggs work into the carcass or into the living flesh, and in the

latter case may cause death. Probably cattle suffer most from screw-worm attack, and hogs, horses, mules, sheep, goats, and dogs follow in the order named. Pupation takes place in the ground. The life cycle is from one to four weeks. There are many generations, and multiplication is enormous where carcasses are left lying in the open.

Control: The complete destruction of all dead animals by burning is the best method of control. If this is impracticable, bury carcasses at least 2 feet underground. Modify range practices so that calves are born between December 1 and May 1. Avoid branding, marking, castrating, and dehorning when screw-worm flies are abundant. For treatment of infested wounds use chemically pure benzol (coal-tar benzene). A mixture of 1 part furfural to 3 parts pine-tar oil acts as a repellent when applied to wounds.

Horn Fly.—The horn fly is somewhat smaller and more slender than the house fly. The eggs are laid on fresh cow manure, and the larvæ develop in the same material. Pupation takes place in the ground beneath the dung. The time elapsing from egg to adult is from 10 to 17 days. The adults are blood suckers and settle in swarms on the backs and sides of cattle.

Control: Accumulations of cow manure should be cleaned up and scattered thinly on agricultural lands at intervals of three or four days in summer. Cow droppings in small pastures may be broken up with a brush drag, thus allowing the manure to dry quickly. Practical control measures for range conditions have not been developed.

Stable Fly.—The adult stable fly resembles the house fly, but is slightly broader and feeds on the blood of animals, which it draws with its long piercing mouth parts. Development through the egg, larval, and pupal stages usually ranges from 21 to 25 days, where conditions are favorable. Breeding takes place in accumulations of various kinds of vegetable matter and also in manure, especially where the manure is mixed with straw. When straw stacks become wet soon after threshing the flies breed in the decaying straw and may produce severe outbreaks.

Control: The numbers of stable flies can be kept down by proper care of stable refuse and by stacking of straw so that the stack will shed water. The use of window traps in stables is often helpful.

Biting Louse of Cattle.—Insect reddish in color, having distinct bands across the abdomen, about one-thirteenth inch in length. Head broad and blunt. The eggs are attached to the hairs of the host and hatch in five to seven days. Under favorable conditions the period from hatching until the young louse is mature and ready to lay eggs is about 14 days. The entire life history takes place on the host.

Control: Dust the host with sodium fluoride.

Sucking Louse of Cattle.—There are two kinds of sucking cattle lice. In one the head is short, nearly as broad as long, and bluntly rounded in front. In the other, the head is long and slender. Abdomen of a bluish color in both species. The eggs are attached to the hairs of the host. Upon hatching, the young lice begin to suck the blood of the host. Maturity is reached in 11 to 18 days from date of hatching.

Control: Apply raw linseed oil lightly with a brush to the animal, or dip in one of the standard stock dips. After using linseed oil do not allow the animal to go out in strong sunlight for at least 12 hours.

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Texas Fever Tick.—Unengorged adults are about one-twelfth inch long. Engorged females are about one-half inch long. Color light yellowish or grayish brown; engorged, grayish blue. The fully engorged females drop from the host to the ground, and in summer egg laying begins 2 or 3 days thereafter. From a few hundred to over 4,500 eggs may be laid by a single female upon the ground. The young seed ticks hatching from the eggs, crawl up on grass blades or other vegetation and wait for a passing animal to establish contact. Two moults take place upon the body of the host. Besides cattle, horses, mules, deer, and sometimes sheep are attacked.

Control: The use of one of the standard arsenical dips will kill all ticks upon infested animals. Pastures may be entirely freed of ticks by keeping out host animals for periods varying from 6 to 11 months, depending upon the time of year the animals are removed.

Spinose Ear Tick.—Adult female from one-fifth to two-fifths inch long, grayish to dark brown in color. The larvæ enter the ears of any of the larger animals with which they come in contact, and remain there until the nymph stage is practically completed. Upon leaving the host the nymphs crawl up several feet from the ground and hide themselves in dry cracks and crevices, and deposit eggs. The young larvæ hatching from the eggs make contact with the host when the animal rubs or brushes against these places.

Control: Inject into the ears of infested animals a mixture consisting of 2 parts ordinary commercial pine tar and 1 part cottonseed oil measured by volume.

Horse and Mule Pests

Horsefly.—Horseflies have sucking mouth parts and vary considerably in size according to species. They are usually large and conspicuous. The eggs are laid near or over water or moist ground, on vegetation or inanimate objects. Upon hatching, the larvæ drop to the water or moist soil. Pupation takes place in dryer situations to which the larva works its way when about ready to pupate. The winter is passed in the larval stage. The female adults are fierce bloodsuckers upon horses and cattle and sometimes spread disease among them.

Control: Drain the areas where breeding takes place. Protect work animals with burlap and other fly nets.

Horse Bot.—The adults are two-winged hairy flies with tapering abdomens, having somewhat the appearance of small bees. According to the species the eggs are laid on the hairs of the legs, jaws, or lips of the host. After hatching, the larvæ enter the mouth of the host and pass to the stomach with the feed or water which the animal takes. Here they pass the winter attached to the stomach wall and attain full growth. They then pass to the ground with the manure, and pupate in the soil.

Control: Administration of carbon disulphide in capsules after the animal has fasted for 24 hours. The carbon disulphide may be given in 3 doses of 3 drams each, at 1-hour intervals, or 2 doses of 4 drams each with a 2-hour interval, or in a single dose of 6 drams.

Sheep and Goat Pests

Sheep Tick.—This is not a true tick, but a wingless fly with sucking mouth parts. Average length of female about ¼ inch. The eggs hatch inside the body of the parent female and the larvæ undergo development there. When about ready to pupate the larvæ are born, and the

covering hardens into a shell about 12 hours thereafter. Pupal period is 19 to 24 days. In about 14 days after emerging from the shell, the young adult deposits its first young. The entire life cycle is spent upon the body of the sheep. The adults suck blood from the host.

Control: Dipping will kill all ticks on the animals so treated. Two dippings should be given, 24 to 28 days apart. The nicotine dips are sold under various trade names. If one of these dips is used, the directions on the container should be followed.

Cat and Dog Pests

Fleas.—As a rule the eggs of species which affect man are laid in the fur or hair of domestic animals. As they are not attached to the hairs of the host many drop off and development takes place in dirt and débris. The dirt in cracks of floors is suitable for the purpose. In the summer time in Washington, D. C., the length of the life cycle from egg to emergence of adult ranges from 17 to 37 days.

Control: Keep cats and dogs out of the house and prevent them from going under the house. Remove all rugs and scrub all floors with soap and water. When the floors are dry apply gasoline or kerosene to them and sprinkle the floors liberally with naphthalene crystals. Leave the naphthalene for a few days without sweeping up. For basements, apply 3 to 5 gallons creosote oil to the floor.

Poultry Pests

Poultry Lice.—All poultry lice have stout cutting or biting mouth parts. They have a flattened form and are fitted with various spines and peculiarly modified legs which assist them in moving about through the feathers. The eggs are laid among the feathers and hatch in a few days. The life cycle is passed on the body of the host.

Control: Dust with dry sodium fluoride or dip in a solution of 1 ounce sodium fluoride to each gallon of water.

Common Chicken Mite.—The common chicken mite is a minute, dark-colored creature with sucking mouth parts. The eggs are laid in the cracks of roosts and chicken houses and hatch in about two days in summer. A blood meal is necessary to the adult female before the deposition of eggs. The life cycle from egg to adult requires about seven days in the summer. These mites usually feed at night and stay in the cracks of roosts and chicken houses during the day.

Control: Make two or three applications of "carbolineum" or crude petroleum to the roosts and buildings.

Fowl Tick.—The adult is a flattened elongate tick, from one-fifth to nearly one-half inch in length, covered with minute granulations and irregular disks. The color varies with the quantity of blood in the individual. The eggs are deposited in the cracks about the henhouse. In warm weather the eggs hatch in 10 to 15 days. Seed ticks sometimes remain on fowls for several days, but adults feed only at night and are found in cracks and protected places during the day.

Control: Spray the chicken house thoroughly as for mites. One to three treatments are necessary to kill all ticks present.

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FOREST AND SHADE-TREE INSECTS

Bark Beetles

Western Pine Beetle.—The beetles attack the trees in great numbers and, boring through the bark, produce characteristic pitch masses at the points of entrance. Small, winding tunnels are extended between the bark and wood, girdling the tree and causing its death. Eggs are deposited along the sides of these tunnels. The insect doing the damage is a small, black, cylindrical beetle, less than one-fourth inch in length, found associated with small, curved larvæ under the bark of dying pines. Injurious to yellow pine throughout California and Oregon.

Control: Peel and burn the bark from infested trees during the winter and spring months.

Black Hills Beetle.—A beetle similar to the western pine beetle but making long, nearly straight, egg galleries beneath the bark, and following the grain of the wood. Along these tunnels eggs are deposited. From these eggs the small larvæ burrow transversely, girdling the tree and causing its death. Injuries to yellow and white pine through the Pacific coast and Rocky Mountain regions.

Control: See Western pine beetle.

Southern Pine Beetle.—A beetle similar to western pine beetle is injurious to yellow and white pine from Virginia southward.

Control: See Western Pine Beetle.

Crude Forest Product Insects

Saw-Log and Green-Lumber Insects.—Pinhole borers (ambrosia beetles) and round or flathead borers cause defects in the green logs or green sawed lumber, which lower the grade of the product or make it entirely useless.

Control: It is necessary to get the green logs cut out of the woods and sawed with the least possible delay. If storage is necessary, the logs should be placed in water or spread out in the sun, preferably held off the ground by means of small poles, where they dry rapidly. If material is of great value it may be practicable to spray the logs thoroughly with coal-tar creosote, which will prevent all insect attack.

Finished Forest-Product Insects

Lyctus Powder-Post Beetle.—The sapwood of seasoned hardwoods is frequently damaged by small white grubs which reduce the wood to a powderlike condition.

Control: It is necessary to have the stock kiln-dried at temperature of 135° F. or over, with a water-saturated atmosphere. The insect can also be killed if the stock is saturated with orthodichlorobenzene applied with a mop or sprayer. Damage can be prevented by the dipping of the stock in linseed oil or similar substances which will close the pores of the wood. To prevent this type of injury establish a system of inspection, classification, and rapid utilization of the dried lumber.

Rustic-Work Insects.—A number of bark beetles and borers attack green or partly seasoned rustic work used in the construction of camps, bungalows, and such structures. Injury can be detected by the exuding of boring dust and peeling off of the bark.

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Control: (1) Paint the bark with coal-tar creosote, exercising particular care to get a good penetration of the oil into all crevices; or (2) remove the bark, apply creosote to the inner surface, and relay, securing it with nails to the logs. After the sticks are infested little can be done, but spraying with orthodichlorobenzene is sometimes very effective.

Termites.—Insects tunneling in lumber often cause the collapse of foundation, floor, wall, and other timbers of buildings. The injury is caused by termites—small, white antlike insects which work unseen in the wood.

Control: Woodwork can be protected by the use of stone, brick, or concrete foundations, concrete lower flooring, or by impregnation of foundation timbers with coal-tar creosote. A thorough examination should be made of the foundation timbers of the building to determine where they are in contact with the ground, and they must be removed from any such contact. Occasionally, however, the wood is kept moist from some other source, such as water leakage, when the termites will continue to work, and the wood will have to be removed.

Shade-Tree Insects

Elm Leaf Beetle.—Leaves of elms are skeletonized by a beetle which when freshly emerged is yellowish with black stripes down the outside margins of the wing covers, but in the spring appears olive green. The larvæ, which also feed on the leaves, are yellowish with black stripes and spots, and grow to one-half inch in length. Two generations usually occur during the year, and all elms are fed upon.

Control: Apply lead-arsenate spray when the buds burst and again two weeks later. Rains after spraying may make a third or even a fourth application necessary. Destroy pupæ at bases of trees by digging up and exposing to weather or by pouring hot water or soapsuds over them. Community action is especially desirable.

Oyster-Shell Scale.—This scale is a small, grayish to brownish, oyster-shell shaped body that is found clustered usually in great numbers on the thinner and smoother barked limbs, branches, and twigs of many of the deciduous shade and ornamental trees and shrubs. The insect overwinters in the egg stage, protected beneath the scale, and the young hatch in the spring. Lilac, maple, poplar, willow, and box are among the trees and bushes most frequently attacked.

Control: Cut off and burn all dead and heavily infested parts that can be spared, and spray in the fall after the leaves drop and again in spring before new growth starts, with a commercial lime-sulphur or a miscible oil. Dilute as recommended by the manufacturer on the container. Lime-sulphur soils paint with which it comes in contact.

White-Marked Tussock Moth.—The caterpillar is more than an inch long when fully grown, and has a red head, three black plumes at the extremities of the body, and four yellow, brushlike tufts of hair with two red spots behind them, on the back. The cocoons are found clustered in sheltered places as in the crevices of the bark of trees. The adult moths issue, and the females lay their eggs in a mass covered with a white, frothlike material usually on or near their cocoons. Two or three generations occur during the year in most localities. Feeds on most deciduous shade and ornamental trees.

Control: Destroy egg masses especially during the winter by hand picking, scraping them off, burning, or dabbing with creosote oil mixed with sufficient turpentine to keep it liquid in the winter and enough lampblack to color. Spray with arsenate of lead when the young caterpillars are first observed. Community action is very desirable.

Bagworm.—The caterpillar incloses itself in a spindle or cigar shaped bag varying in size up to 2 inches in length, and it is covered with pieces of the plant fed upon. Protruding from the upper end of this shelter the head and six legs of the caterpillar can be seen. Hibernation takes place in the egg stage within the bags. The larvæ feed on arbor vitæ and other evergreens by preference but will attack broad-leaved trees and shrubs.

Control: Collect and destroy the bags during the winter. Spray with arsenate of lead.

Borers.—These insects often attack the wood of trees, especially the dead wood around untreated wounds. These borers represent many species, most frequently the grubs of beetles, but some are the caterpillars of moths.

Control: Removal and destruction of the insect-infested and decaying wood is essential. This work should be thoroughly done and all wood cut out that shows borer galleries or decay. The wound or wounds should then be cleansed and thickly coated with a waterproof preservative, such as a mixture of equal parts (by weight) of asphaltum and creosote, or one-fourth creosote and three-fourths coal tar, or a good white-lead paint. These materials must not be applied so as to come in contact with the freshly cut edges of the living bark, where a shellac should be used. Then the trees should be invigorated by the application of fertilizer and plentifully supplied with water. This stimulation is best given in the spring, and ought not to be used when freezing weather approaches. At intervals the treated wounds must be examined to determine their condition, and when necessary fresh coatings of preservative should be applied.

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STORED-PRODUCT AND HOUSEHOLD INSECTS

Grain and Grain-Product Insects

Black Weevil.—A small snout beetle about one-eighth inch long, reddish brown or nearly black in color, with four light reddish or yellowish spots on the back. The adults fly from granaries to the field and in the South begin to lay eggs on any exposed corn kernels as soon as corn reaches the roasting-ear stage. From then on the injury increases, and often ears in late-harvested corn with poor shuck covering may be entirely destroyed before harvest. Throughout the Gulf coast region corn and other grains are generally infested when placed in storage, and by the following midsummer are rendered practically unfit for feed except for hogs and chickens.

Control: Fumigate with carbon disulphide or carbon tetrachloride. Carbon disulphide has given the greatest satisfaction.

Angoumois Grain Moth.—This is a small buff or yellowish-brown moth with a wing expanse of about one-half inch. Its larva attacks all cereal grains and is particularly injurious in the South to corn, and to wheat in the Middle Atlantic region. The female moth flies from the granary to the field and there lays her eggs on the ripening grain. The larva, on hatching from the egg, bores into the kernel usually at the germ, and feeds in the interior of the seed, materially reducing its weight.

Control: Heating grain to 125° F. or fumigating in tight bins with carbon disulphide or carbon tetrachloride. Wheat should be harvested as soon as ripe and threshed early.

Bean and Pea Insects

Bean and Pea Weevils.—The first evidence of bean and pea weevil attack upon common garden and navy beans, cowpeas, and peas is the characteristic round hole made by the adult beetle when it leaves the seed. These beetles are dark colored and measure from one-eighth to one-fifth inch long. In garden pea and the broad beans there is but one generation each year, but in navy and garden beans and cowpea there are several generations. These weevils usually start the infestation by laying eggs upon the seeds or pods as the plants are maturing in the garden or field, and are carried into storage with the seeds. Weevily beans and peas often heat badly, which favors weevil increase.

Control: Heat the seeds at 120 to 125° F. for a short time either in an oven, when only small quantities are treated, or in a commercial machine when it is desired to treat larger quantities. Fumigate with carbon disulphide or carbon tetrachloride. When large quantities of seeds are stored in sacks, fumigation with hydrocyanic-acid gas is effective.

Fabric Insects

Clothes Moths.—These are small, wormlike larvæ of little gray or whitish moths. They breed in clothing, carpets, rugs, upholstered furniture, brushes, the hair and lint in cracks, or in any article into the composition of which enter wool, fur, hair, or feathers.

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Control: Badly infested houses should be fumigated with hydrocyanic-acid gas or sulphur dioxide. Clothing in chests, closets, and tight containers not in daily use can be protected by use of naphthalene or paradichlorobenzene. Moths in furs and clothing can be killed within a few hours if the garments are placed in tight chests or closets and fumigated with carbon disulphide or carbon tetrachloride. Cedar chests protect against damage if only very young larvæ are present when the clothing is placed in the chests, but will not protect if older larvæ are present. Cold storage as high as 40° F. will protect against damage. Dry heat (130° F.), hot water (140° F. for 10 seconds), and soap solutions will kill moth eggs and larvæ.

Carpet Beetles.—Reddish-brown, black, or golden-brown, hairy grubs, about one-fourth inch long, that attack fabrics and other articles made of wool, hair, fur, feathers, silk, and the like, are the larvæ of carpet beetles. Elongate oval beetles lay eggs in fabrics or overstuffed furniture, in cracks of floors, and elsewhere.

Control: Clothing in trunks can be fumigated by use of naphthalene and paradichlorobenzene, carbon disulphide, or carbon tetrachloride. Closets, rooms, or entire houses should be fumigated with hydrocyanic-acid gas, carbon disulphide, carbon tetrachloride, or cyanogen chloride. Cold storage for fur and woolens is a sure protection.

Meat and Dairy-Product Insects

Ham Beetles.—Several species of beetle attack cured hams, shoulders, and bacon. The ham beetle is shiny green, about one-fourth inch long, and its larva is purplish and about one-half inch long. The larva is responsible for most of the damage to infested meats. The larvæ of the hide beetle and of the larder beetle, two other common insects attacking cured meats, are fully five-sixteenths inch long, clothed with long, bristly hairs.

Control: Beetles attacking cured meats can best be controlled by scrupulous cleanliness and screening of all meat-storage places, careful attention being paid to prompt and thorough wrapping of cured meats. Fumigate with hydrocyanic-acid gas.

Cheese Skipper.—The cheese or ham skipper is, in the adult stage a small, shiny black fly less than one-fourth inch long, very active, resembling somewhat a winged ant. Eggs are laid on the meat or wrappings and hatch in about one day in warm weather. During summer weather there may be two generations of skippers each month.

Control: (1) Screen tightly with wire cloth, 30 meshes to the inch, to keep flies from entering storage rooms; (2) wrap each piece of meat in paper and inclose the whole in a tight cloth sack, often adding a coating of yellow wash. On farms and in retail stores a closet or cage with sides of 30-mesh wire cloth should provide safe storage for cured meats. On farms such a cage should render wrappings, sacks, and washes unnecessary. Smokehouses should be screened. A thorough fumigation with hydrocyanic-acid gas (double the dosage given) will kill all insects free in storage rooms, but can not be depended upon to kill those within the meat itself. When meat is so badly infested that it can not be reconditioned by the cutting away of infested parts it should be promptly destroyed.

Dried-Fruit Insects

The principal pests of dried fruits are Indian meal moth, the fig moth, dried-fruit beetle, saw-toothed grain beetle, and two sugar mites. The two moths cause the fruits to become webby.

Control: Uninfested supplies of dried fruits in the home can be protected if inclosed in tight containers to which insects can not gain access. In stores and warehouses they are better controlled by fumigation with hydrocyanic-acid gas or carbon disulphide or by placing the fruits in cold storage.

Miscellaneous Stored-Product and Household Insects

Cockroaches.—Four species of cockroach are troublesome in American dwellings, offices, warehouses, ships, and other structures. The American roach, often more than 1½ inches long, is the largest; the croton bug, about five-eighths inch long, is the smallest. The oriental roach and the Australian roach are nearly as large as the American roach.

Control: The liberal use of sodium-fluoride powder dusted about places they inhabit and the use of phosphorous pastes are the best all-round cockroach controls. Phosphorous pastes should be put on a cardboard made in a roll large enough to allow the roach to enter and to eat the paste; this will prevent the paste from soiling house furnishings. Fumigation with hydrocyanic-acid gas is effective.

House and Lawn Ants.—Many species of house and lawn ants are troublesome about the household.

Control: Successful control consists in discovering the location of the nests and killing the queens and young with boiling water, kerosene, or with carbon disulphide. The surest way to keep a house free from ants is to have no food lying about. One pound of sugar dissolved in 1 quart of water, to which is added 125 grams of arsenate of soda is a good poison for ants. It should be poured into a shallow dish and placed where ants congregate. This mixture is very poisonous and should be used with care. To kill ants in lawns, punch shallow holes with the end of a broom handle every 3 or 4 inches over the infested area, and into the shallow holes pour 1 or 2 tablespoonfuls of carbon disulphide, and plug the holes.

Pantry Pests.—They attack flour, breakfast foods, and other cereals, dried fruits, and nut meats. They are cosmopolitan pests that are brought into the home with grocery supplies. The Indian meal moth and the Mediterranean flour moth cause foods to get webby. In their immature or larval stages they are greenish-white or pinkish worms about one-half inch long. The small flour beetles and the rice and granary weevils are also frequently present, but cause no webbing.

Control: Search out the neglected food supply in which they are breeding, destroy it by burning, clean and wash the pantry shelves, especially the cracks, and purchase new supplies only in small quantities until the infestation has disappeared. Buy susceptible foods only in small quantities in warm months, and dispose of them entirely before closing house for summer vacation period.

Silverfish.—The silverfish is a glistening, silver or pearl-gray insect, with three taillike appendages, about as long as the body itself, which often increase the length of the insect to about seven-eighths inch. From dark recesses when books, papers, clothing or other articles are suddenly

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removed, these insects on being exposed to the light glide quickly out of sight. The silverfish is a common household pest, but because it shuns the light and runs rapidly to places of concealment, it is often very abundant without the knowledge of the housekeeper. It feeds upon starch and glue in bookbindings and papers, and in linens, laces, muslin curtains, and upon silks containing sizing, and in so doing often eats holes in the fabric itself.

Control: Flour paste made of 1 pint of flour, one-half to three-fourths ounce of white arsenic, and water is a good remedy. Mix the arsenic and flour and add sufficient water to make a thin paste by boiling. Place in a flat receptacle where insects may eat it. For starched clothing and similar objects, frequent handling and airing, and destruction by hand of all silverfish, are recommended.

Book Louse or Psocid.—Book lice are tiny, white or grayish-white insects, scarcely as long as the width of an ordinary pinhead, and often much smaller, that appear in houses in greatest numbers during late summer and early fall, and are more abundant in damp, well-shaded rooms not in general use. Book lice run in a halting fashion. They feed on all sorts of vegetable and animal matter, and are more abundant in rooms with overstuffed furniture, or with cushions containing vegetable matter. They do not injure man, and cause almost no injury to house furnishings, but their presence annoys exceedingly the thrifty housewife. They die off with the approach of cold weather.

Control: Thorough sunning and drying of furnishings, fumigation with hydrocyanic-acid gas or sulphur, and heating to a temperature of 130° F. are effective control measures.

BEEKEEPING

General

Beekeeping affords a source of income, a pleasurable pastime, and an important means of cross-pollenizing economic plants. Efficiency depends on the study and effort which the beekeeper puts on the principles back of the various manipulations. The study of the bees themselves must not be neglected, for beekeeping practice depends on a knowledge of bee behavior. The specialist in beekeeping who keeps bees efficiently finds the work profitable.

Purchase of Bees.—To start beekeeping or to increase colonies by purchase, the most commendable plan is to buy up colonies locally. The purchase of bees in combless packages is not advisable for the beginner.

Sources of Honey.—Notably clover, buckwheat, tulip tree, alfalfa, sweet clover, fireweed, basswood, orange, and sage are sources of honey. In southern and southeastern United States, the honey plants are principally sourwood. gallberry, mangrove, tupelo, and palmetto. The Southwest produces considerable honey from mesquite, hunjilla, and the like. In no part of the country is it profitable to grow a crop for honey alone. Probably not one-tenth of the nectar produced is now collected by bees.

Management

Spring Management.—If the colony is weak in the spring, concentrate the bees with a division board, and feed sirup as directed under feeding. However, it is recommended that sufficient honey be allowed to remain with the bees in the fall so that spring feeding will not be necessary. This quantity is about 45 to 50 pounds and is more than can be stored in one standard brood chamber with sufficient room for spring brood rearing. The use of the two-story brood chamber of two standard 10-frame hives is recommended, reducing the brood chamber to one story for the honey flow if comb honey is being produced.

Feeding.—During spring manipulations, in the preparation of bees for winter, and at other times, it may be necessary to feed bees for stimulation or to provide stores. Honey from an unknown source should never be used for fear of introducing disease; sirup made of granulated sugar is cheapest and best for this purpose. The cheaper grades of sugar or molasses should never be used for winter stores. The proportion of sugar to water depends on the season, and the purpose of the feeding. For stimulation a proportion of one-fourth to one-third sugar by volume is enough, and for fall feeding, especially if rather late, a solution containing as much sugar as it will hold when cold is best. There seems to be little advantage in boiling the sirup.

Handling.—A smoker, hive tool, and veil are the beekeeper's essential tools. Gloves may be worn, but are usually in the way. The clothing may be fastened at the wrists and ankles to prevent bees from entering. The best time to handle bees is during the honey flow, and particularly during the middle of warm days. Never handle bees at night, or on cold, wet days. The outer cover of the hive is taken off as gently as possible.

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With the hive tool the inner cover is pried up and a puff of smoke is blown into the narrow crack before any bees emerge. Just enough smoke is used to drive back any bees that show signs of attacking. Frames are loosened with the hive tool, and are moved slightly farther apart so that one frame may be lifted out without crushing bees. In examining a frame, hold it over the hive so that any bees or the queen in falling, will drop into it.

Transferring.—This operation is the removal of bees from a box hive or gum into a movable-frame hive. A fair crop of honey can be obtained only if the beekeeper is able to examine the bees and to move combs as needed. Transferring can be done at any time that the bees are not inclined to rob. A good time is during fruit bloom or immediately after the casting of a swarm. Transfer the first few colonies in the afternoon so that, if robbing does begin, it will stop with night. The box hive should be moved a few feet from its stand, and in its place should be put a hive with movable frames containing full sheets of foundation. The box hive should be turned upside down and a small, empty box inverted over it. Apply smoke and drum continuously on the box hive with sticks for a considerable time. This will cause the bees to desert their combs and to go to the upper box. When most of the bees are clustered above, they may be dumped in front of the entrance of the new hive. It is necessary that the queen be in the hive before this manipulation is finished. The old box hive containing the brood may now be placed right side up in a new location, and in 21 days all the worker brood will have emerged, and probably some new queens will have been reared. These bees may then be drummed out and united with their former mates if both colonies are smoked vigorously and the newly emerged bees are allowed to enter the hive through a perforated zinc that keeps out the young queens. If little honey is being gathered, the colony in the hive must be provided with food.

Wintering.—The important considerations in wintering are plenty of young bees, a good queen, plenty of stores of good quality, sound hives, and proper protection from cold and dampness. If, as cold weather approaches, the bees do not have stores enough, they must be fed. Every colony should have from 25 to 40 pounds of honey, depending on the length of winter and the methods of wintering. The bees should be provided with stores early enough so that it will not be necessary to feed or to open the colonies during cold weather. In the South no packing is necessary, and even in very cold climates good colonies with plenty of stores can often pass the winter with little protection. However, packing and protection make it necessary for the bees to generate less heat, so that they consume less stores and their vitality is not reduced. Dampness is probably harder for bees to withstand than cold. When packing, remove the outer cover, leaving the inner wooden cover to be sealed down tightly by the bees. Entrances should be contracted in cold weather, not only to keep out cold wind, but to prevent mice from entering. There should always be enough room, however, for bees to pass in and out if warmer weather permits a flight. A convenient packing case can be made by the use of tongue and groove lumber fastened together with cleats to form the four sides of a rectangular box large enough to allow from 6 to 8 inches on all sides and from 8 to 12 inches on top. This space is filled with packing material such as closely packed dry leaves, sawdust, or grain chaff.

The sides of the case can be fastened together with hooks to facilitate summer storage. The top should be made to telescope over the sides and should be covered with tin or roofing material. The bottom is made similar to the sides. The hive or hives are elevated above the bottom of the case to allow 4 inches of packing beneath. A tunnel must be provided to allow the bees to pass from the hive to the outside of the box. This can be made with two pieces of board, filling the space above and below the beeway, and communicating with auger holes through the outer wall. A convenient-sized box accomodates four hives, placed in a rectangle with the entrances outward.

For the dates of placing in and removing from winter quarters, consult the State extension entomologist or the Bureau of Entomology, United States Department of Agriculture. In the colder regions cellar wintering is successful, but this method requires careful study. The winter stores must be good. The cellar must be so protected that the temperature never varies more than about 5° F.; 43° F. is the usual cellar temperature, but is rather low. Little ventilation is necessary except what is required for controlling the temperature. If the bees are quiet at 45° and there is no condensation of moisture, the cellar conditions are probably good, but if the bees are noisy with cellar temperature at 45° the cellar is probably too dry. Light should not be admitted to the cellar, and consequently some means of indirect ventilation is necessary. With moisture and temperature of the cellar under control, bees should winter well if the food is good.

Diseases

Beekeepers in many parts of the country are suffering losses from two serious brood diseases—American and European foulbrood. If diagnosis is difficult, send samples to the State extension entomologist or to the Bureau of Entomology, United States Department of Agriculture, for examination. Many States have apiary inspection for the detection of these diseases and for the instruction of beekeepers in their control.

Marketing

An important task of the beekeeper is to dispose of his product at a profit. Honey should be placed in neat and clean containers, and the beekeeper should always have a sufficient stock of honey to supply his customers. The sale of honey can be greatly increased by proper advertising.

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CONTROL OF INSECTS

Stomach and Contact Poisons

(See 13.82.)

Lead Arsenate.—Commercial lead arsenate is at present the safest form of arsenical compound for use on trees in foliage. It is sold in powder and paste form. To meet legal requirements it must contain total arsenic equivalent to not less than 12½ per cent arsenic oxide, arsenic in water-soluble forms equivalent to not more than 0.75 per cent of arsenic oxide, and not more than 50 per cent water.

Lead arsenate spray.—Mix to thin paste with water, place in the spray tank with the required quantity of water, and churn thoroughly with the agitator. For external leaf-eating insects on fruit trees use 1 pound of the powder or 2 pounds of the paste for each 50 gallons of water. For such insects attacking truck crops the general formula is 2 pounds of lead arsenate powder in 50 gallons of water. Lead arsenate may be used safely with each of the following ingredients: Nicotine sulphate, winter strength, lime-sulphur solution, self-boiled lime and sulphur mixture, Bordeaux mixture, kerosene emulsion, and soaps. Sodium and potassium sulphides and the so-called soluble sulphur preparations are not compatible with it. On peach, plum, and cherry and other plants with tender foliage add milk of lime as directed in spray schedule.

Lead arsenate dust.—Powdered lead arsenate mixed with superfine sulphur, hydrated lime, or gypsum is dusted on foliage to kill external leaf-eating insects. For dusting orchard trees, truck crops, and some ornamental plants 10 to 15 pounds of lead arsenate and 90 or 85 pounds of one or several of the other substances are mixed. The 15–85 mixture is preferable for potato beetles and cabbage worms, and from 25 to 30 pounds of the dust per acre is required for one application. For stone fruits at least 15 pounds of the dilutent should consist of hydrated lime.

Calcium Arsenate.—*Undiluted powdered calcium arsenate* is used largely to dust cotton for the boll weevil. It should not have less than 40 per cent total arsenic oxide, 0.75 per cent water-soluble arsenic oxide, and a density of 80 to 100 cubic inches per pound. For cotton 5 to 7 pounds per acre of the undiluted powder should be used for each application. Calcium arsenate dust may be used on truck crops in the same dilution as lead arsenate dust.

Paris Green.—This is used for chewing insects on certain truck crops, but is unsafe on peach, cherry, and plum foliage and should always be combined with Bordeaux mixture or hydrated lime when applied to other orchard trees. For spraying use 6 ounces of Paris green and 3 pounds of hydrated lime in 50 gallons of water. Do not combine with lime-sulphur solution. For dusting mix 1 part by weight of Paris green with 15 parts of hydrated lime and dust lightly on the plants. This mixture can be used only on resistant plants like potato and cabbage. Sow bugs in greenhouses are controlled by scattering over the benches a mixture of 1 part Paris green and 9 parts sugar.

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Poisoned Bran-Mash Bait.—Poisoned bran baits are used to control grasshoppers, cutworms, and army worms. For grasshoppers use 25 pounds wheat bran, 1 pound white arsenic or Paris green, 2 quarts cheap molasses, 2 to 3 gallons water, 6 lemons or oranges finely chopped, or three-fourths ounce technical grade amyl acetate. Mix the bran and arsenical thoroughly, then add the other ingredients and mix again. If sodium arsenite is used as the poison the following proportions are used: Wheat bran, 25 pounds; amyl acetate, ¾ ounce; sodium arsenite solution (saturated), 4 ounces; water, about 3 gallons. The amyl acetate and sodium arsenite solution are added to the water, and the resulting solution is mixed thoroughly with the bran. For cutworms and army worms the fruit or amyl acetate may be omitted. For green June beetles use only the dry mixture of bran and arsenical. Apply as directed in the control of the respective insects.

Corrosive Sublimate.—(See Truck-Crop Insects.) This substance may also act as a contact poison.

Argentine-Ant Bait.—(See Southern Field-Crop Insects.)

Sodium Fluoride.—This is a white powder used to rid houses of cockroaches and to kill biting lice of poultry and cattle. For roaches, sprinkle around sink, shelves, and in corners. For biting lice of poultry, apply as a dry powder or solution. *Sodium fluoride is poisonous to man when taken into the stomach.*

Hellebore.—(See Fruit Insects.)

Concentrated Lime-Sulphur Solution.—Satisfactory concentrated lime-sulphur solution may be purchased or made as follows:

Formula.—Sixty pounds fresh stone lime (containing 90 per cent or more of calcium oxide), 120 pounds commercial ground sulphur, and water to make 50 gallons of finished solution.

Preparation.—Place 10 gallons of water in the cooking kettle and start the fire. Slake the lime, adding more water as required. When slaking is under way, add the sulphur, stir vigorously, and bring the total volume up to 55 gallons with water. Boil for one hour. If the cooking is done by steam it is not necessary to add the extra 5 gallons of water. When the cooking is completed, strain the solution into barrels and keep tightly closed.

Dilution.—Dilute according to the following table, using a hydrometer to test the solution. The temperature of the solution should be about 60° F.

Dilution of concentrated lime-sulphur solution

Hydrometer reading	Specific gravity	Winter (dormant) strength (for San José scale)	Summer strength (for trees in foliage)[1]
° Baumé		*Gallons concentrate in 50 gallons*	*Gallons concentrate in 50 gallons*
36	1.330	5½	1¼
35	1.318	5½	1¼
34	1.306	6	1½
33	1.295	6¼	1½
32	1.283	6½	1½
31	1.272	6¾	1½
30	1.261	7	1¾
29	1.250	7¼	1¾
28	1.239	7½	1¾
27	1.229	8	2
26	1.218	8½	2
25	1.208	8¾	2
24	1.198	9¼	2¼
23	1.188	9¾	2¼
22	1.179	10¼	2¼
21	1.169	11	2½
20	1.160	11½	2½

[1] Do not use concentrated lime-sulphur solutions on stone fruits (peaches, cherries, plums, etc.). See self-boiled lime-sulphur mixture.

Self-Boiled Lime and Sulphur Mixture.—For scale insects, especially the crawling young, and as a fungicide on peach and other stone fruits in foliage. It is not intended to take the place of a dormant spray.

Formula.—Eight pounds stone lime, 8 pounds ground sulphur, and 50 gallons water.

Preparation.—Place the lime in a barrel, and cover with water. When the lime begins to slake, add the sulphur. Stir constantly and add water gradually till the mixture is converted to a thin paste. When the lime is well slaked, add cold water to cool the mixture and to prevent further cooking. Then strain the mixture into the spray tank and dilute with the required quantity of water. It is then ready for use.

Nicotine.—This is employed in sprays, dusts, and as a fumigant for the control of many insects.

Spray.—Commercial nicotine-sulphate solution containing 40 per cent by weight of nicotine is effective in sprays for aphids, thrips, and certain other insects. It should be applied so thoroughly that the bodies of the insects are covered by the solution. One pound of the 40 per cent liquid is equal to approximately 1 pint liquid measure.

Dilution A (1 to 800): Use one-half pint of the 40 per cent solution in 50 gallons water.

Dilution B (1 to 1,066): Three-eighths pint (6 fluid ounces) in 50 gallons water.

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Dilution C (1 to 1,600): One-fourth pint in 50 gallons water. (See spray-dilution table.)

Add 2 to 3 pounds (or bars) of soap previously dissolved in water as a spreader, the quantity depending on the type of foliage to be sprayed and the hardness of the water used. Plants with smooth, waxy leaves, such as cabbage, generally require a more soapy spray than others.

Nicotine dust.—This is a mixture of nicotine and a dust carrier, usually hydrated lime. A 2 per cent dust is recommended for general purposes. It may be obtained from insecticide dealers or mixed at home. For information on home-mixed dusts consult your local entomologist.

Tobacco dust.—Commercial tobacco dust (finely ground tobacco refuse) is used in certain control operations. It can be obtained from insecticide dealers.

Fumigant.—Nicotine vapor is used to fumigate aphids in greenhouses. Nicotine solutions containing free nicotine may be vaporized by lamps or painted with a brush or poured directly upon the heated pipes in the greenhouse to expel the nicotine. Commercial tobacco paper and powders (materials impregnated with nicotine) are burned in greenhouses to rid them of insects. Directions for their use are furnished with the material.

Kerosene Emulsion.—Employed as a contact spray for many insects. Heat one-half pound of hard soap or 1 quart soft soap in 1 gallon of water till the soap is dissolved. Remove from fire, and add gradually 2 gallons of kerosene, stirring constantly; then mix by pumping back and forth with a spray pump till a creamy emulsion is produced.

Dilution A (5 per cent oil): Three and three-fourths gallons of the above stock solution in 50 gallons of water.

Dilution B (10 per cent oil): Seven and one-half gallons in 50 gallons water.

Dilution C (20 per cent oil): Fifteen gallons in 50 gallons of water.

Dilution D (25 per cent oil): Seventeen gallons in 50 gallons water. (See spray-dilution table.)

Lubricating-Oil Emulsion.—*Boiled emulsion.*—Two gallons lubricating oil (24° to 28° Baumé), 1 gallon water, and 2 pounds (1 quart) potash fish-oil soap (or 1 pound hard soap) are placed in a kettle and brought just to a boil. The mixture is then pumped till thoroughly emulsified.

Cold-stirred emulsion.—Eight pounds (1 gallon) of potash fish-oil soap is dissolved in 1 gallon of water. Add 2 gallons lubricating oil gradually, stirring vigorously after each addition. Continue stirring till all the oil has disappeared from the surface. Dilution A.—Three-fourths gallon of the above stock solution (either formula) in 50 gallons water. Dilution B.—One gallon in 50 gallons water. Dilution C.—One and one-half gallons in 50 gallons water. (See spray-dilution table.)

Crude Petroleum-Oil Emulsion.—Used on the Pacific coast as a dormant spray for the control of scale insects and lichens. Make in a 200-gallon spray tank, using 20 pounds hard fish-oil soap, 4 pounds caustic soda, 24 gallons asphalt-base crude oil (16° to 22° Baumé), 176 gallons of water. Dissolve the soap in 15 gallons water, pour this and the caustic soda into the spray tank, and dilute with water to the 176-gallon mark. Start the agitator, add the 24 gallons of oil, and continue running the agitator a few minutes. The emulsion is then ready to spray on the trees.

Miscible Oils.—Miscible or soluble oils are proprietary petroleum-oil mixtures used largely as dormant sprays for scale insects and insect eggs. Use as directed on the container.

Soaps.—Solutions of laundry soap, fish-oil or whale-oil soaps are often used as contact sprays for aphids and other soft-bodied insects. For aphids on house and greenhouse plants dissolve 1 pound of soap in 4 gallons of water, applying the solution while warm. For scale insects on hardy ornamental plants use 1 pound of soap in 2 gallons water. For San José scale use 2 pounds of soap per gallon of water, applying the solution while hot.

Resin soap.—This is often added to arsenical sprays to increase the adhesiveness of the poison to the foliage. Use about the same weight of commercial resin soap as of arsenical in the spray mixture.

Pyrethrum.—Pyrethrum, a pulverized plant material, is an effective contact poison for many insects. It deteriorates rapidly and should be used only when fresh, and should be kept in tight containers. Dust with the dry powder alone or mixed with flour. Spray with 1 ounce to 1 gallon of water, adding one-half ounce of soap to the mixture.

Sulphur.—Finely powdered sulphur may be dusted on plants or trees for the control of red spider and other mites. It may be used pure or mixed with 1 part of hydrated lime, gypsum, or flour, and 9 parts sulphur. When applied as a spray it should first be made into a paste. Ten pounds of sulphur in paste form and 2 pounds of soap are added to 50 gallons of water.

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Spray-dilution table

Spray	Total gallons of diluted spray								
	200	150	100	50	25	10	5	3	1
Lead arsenate (powder):									
1 lb. to 50 galls	4 lbs	3 lbs	2 lbs	1 lb	½ lb	3 oz	1½ oz	1 oz	3 tspn.
2 lbs. to 50 galls	8 lbs	6 lbs	4 lbs	2 lbs	1 lb	6½ oz	3 oz	2 oz	6 tspn.
(Use double this quantity of the paste lead arsenate.)									
Paris green: 6 oz. to 50 galls	1½ lbs	1⅛ lbs	12 oz	6 oz	3 oz	1 oz	½ oz	1½ tspn	½ tspn.
Lime-sulphur concentrate (33° Baumé):									
Dormant strength (1 to 8)	25 galls	18¾ galls	12½ galls	6¼ galls	3⅛ galls	1¼ galls	2½ qts	3 pints	1 pint.
Summer strength (1½ to 50)	6 galls	4½ galls	3 galls	1½ galls	3 qts	2½ pints	1 pint	½ pint	¼ pint
Self-boiled lime-sulphur mixture (8-8-50).	32–32 lbs	24–24 lbs	16–16 lbs	8–8 lbs	4–4 lbs	1½–1½ lbs	12–12 oz	7–7 oz	2½–2½ oz.
Nicotine sulphate (40%): [1]									
A. 1 to 800 (½ pt. in 50 galls)	1 qt	1½ pints	1 pint	½ pint	¼ pint	10 tspn	5 tspn	3 tspn	1 tspn.
B. 1 to 1,066 (⅜ pt. in 50 galls)	1½ pints	1⅛ pints	¾ pint	6 fl. oz	3 fl. oz	8 tspn	4 tspn	2½ tspn	¾ tspn.
C. 1 to 1,600 (¼ pt. in 50 galls.)	1 pint	¾ pint	½ pint	¼ pint	⅛ pint	6 tspn	3 tspn	2 tspn	½ tspn.

Kerosene emulsion:									
A. 5 per cent spray	15 galls	11¼ galls	7½ galls	3¾ galls	2 galls	3 qts	3 pints	2 pints	½ pint.
B. 10 per cent spray	30 galls	23 galls	15 galls	7½ galls	3¾ galls	1½ galls	3 qts	2 qts	1 pint.
C. 20 per cent spray	60 galls	45 galls	30 galls	15 galls	7½ galls	3 galls	1½ galls	7 pints	2½ pint.
D. 25 per cent spray	76 galls	57 galls	38 galls	19 galls	9½ galls	4 galls	2 galls	1 gall	3 pints.
Lubricating-oil emulsion:									
A. 1 per cent oil	3 galls	2¼ galls	1½ galls	¾ gall	1½ qts	1¼ pints	½ pint	5 oz	⅛ pint.
B. 1.3 per cent oil	4 galls	3 galls	2 galls	1 gall	½ gall	1½ pints	¾ pint	½ pint	3 oz.
C. 2 per cent oil	6 galls	4½ galls	3 galls	1½ galls	3 qts	1 qt	1 pint	½ pint	¼ pint.
Laundry or fish-oil soap: 1 lb. to 4 galls.	50 lbs	37½ lbs	25 lbs	12½ lbs	6¼ lbs	2½ lbs	1¼ lbs	¾ lb	¼ lb.

[1] 1 pound equals approximately 1 pint.

Fumigants

Hydrocyanic-Acid Gas.—This is used for the fumigation of citrus trees on the Pacific coast, for nursery stock, greenhouse pests, and insects infesting mills, warehouses, and dwellings. It is *extremely poisonous to human beings,* animals, and plant life, and should be used only by persons familiar with it.

Fumigation of houses.—Use 1 ounce of sodium cyanide (98 per cent pure), 1½ fluid ounces of commercial sulphuric acid (specific gravity 1.83, or 66° Baumé) and 2 fluid ounces of water for each 100 cubic feet of space. See that the entire building is vacated. Fumigation should start at the top of the building and be carried out in such a way that it is not necessary to enter a room which is undergoing fumigation. Remove all moist foodstuffs from the rooms to be treated. Place the required weight of sodium cyanide in a thin paper bag. Pour into an earthenware jar the computed quantity of water and add the acid slowly. (*Never pour the water into the acid.*) A jar of 4-gallon capacity will generate conveniently 3 pounds of sodium cyanide; no more than this should be used in one receptacle. After the room has been made tight, one or two windows being left unlocked to permit ventilation later from the outside, drop the bag of sodium cyanide into the acid solution, and *leave the room at once.* Expose for 4 to 24 hours, preferably when the temperature is 70° F. or above, never below 50°. Ventilate the house thoroughly for at least eight hours before occupying it.

Scale eradication on citrus trees.—The following three methods are in use for the destruction of scale insects on citrus trees. (Consult the State extension entomologist for dosage schedules and other particulars.)

Pot method: An 8-ounce duck-cloth tent is drawn over the tree, and the gas is generated from sodium cyanide, sulphuric acid, and water in a glazed earthenware vessel inside the tent.

Fumigating-machine method: A specially constructed machine is charged with sodium-cyanide solution (4 pounds sodium cyanide to 1 gallon water) and a solution of sulphuric acid and water, each occupying a separate compartment. When ready to fumigate, the required quantities of cyanide and acid are mixed, and hydrocyanic-acid gas is generated and conducted into the tent through a hose.

Liquid hydrocyanic-acid method: Liquid hydrocyanic acid of 96 to 98 per cent purity is liberated in a fine mist beneath the tented tree by means of a machine which accurately measures the dosage. Because of its great volatility, this liquid soon becomes a gas. Other types of machine are equipped with heating devices which volatilize the liquid before it is delivered into the tent.

Greenhouse fumigation.—Fumigate at weekly intervals, using one-half ounce sodium cyanide, three-fourths ounce commercial sulphuric acid, and 1½ ounces water for each 1,000 cubic feet of space for aphids, thrips, and young scales. For aphids on cucumbers under glass use one-fourth this dosage and expose over night. For white fly use one-half this dosage. For scale insects on palms, orchids, ferns, and other hardy greenhouse plants use 1 ounce sodium cyanide, 1 ounce commercial sulphuric acid, and 3 ounces of water for each 1,000 cubic feet. Expose for one hour. Do not fumigate "florists' greens" or snapdragons with hydrocyanic-acid gas.

The above method is rapidly being superseded by the calcium-cyanide process: Calcium cyanide, a new chemical insecticide, is being used as a convenient source of hydrocyanic-acid gas for greenhouse fumigation. On exposure to the air it reacts with the atmospheric moisture and gradually gives off hydrocyanic-acid gas. Unlike sodium-cyanide fumigation by the "pot method," this material does not require the addition of acid and water to generate the gas. The gas given off is the same in both cases and is therefore just as poisonous and requires the same precautions. Several forms of calcium cyanide are now available on the market, but the dust and granules seem best adapted to greenhouse use. The dust is more finely ground, and appears to give off the gas more readily than the granules. It is especially useful for controlling the adults of white flies and the various forms of aphids that attack the principal commercial crops. Because of its gradual liberation of gas, calcium cyanide is better suited for overnight fumigation. In this respect it differs from the "pot method" which liberates the gas from sodium cyanide almost instantly, and normally requires only one hour's exposure.

Dosages for fumigating greenhouses are expressed in ounces of calcium cyanide for each 1,000 cubic feet of air space. The correct dosage depends upon the tightness of the house, the insects controlled, and the susceptibility of the plants to injury.

To determine an effective dosage for overnight exposure, begin with the one-fourth-ounce rate and note the effect on plants and insects. If no injury to the plants occurs and if any insects survive, the dosage may be increased to one-third or one-half ounce or higher until the desired results are obtained. Normally the one-fourth-ounce rate suffices for the control of adult white flies and the various aphids that attack roses, carnations, and other commercial crops. Exposed thrips should also succumb to this strength. Successive fumigations at regular intervals of 10 days or two weeks persistently followed will doubtless control the immature stages of mealybugs and scale insects, the dosage depending on the plant to be fumigated.

Roses, chrysanthemums, carnations, snapdragons, sweet peas, geraniums, calendulas, salvias, fuchsias, and primroses will tolerate one-fourth-ounce strength, although some slight burning may occur on some of the tender growth. Orchids, palms, ferns, begonias, and similar resistant plants may stand even higher dosages. Snapdragons, asparagus, sweet peas, and marguerites are more easily burned by the gas, hence in houses where they are growing all precautions must be observed. The florist who has plants that are easily burned must choose between the loss which results from continued insect injury and that due to fumigation, which is only temporary.

How to fumigate.—(1) Determine the inside measurements and calculate the cubical contents of the house or houses to be fumigated.

(2) Close ventilators and all openings as tightly as possible, and also repair any broken glass.

(3) Weigh the required quantity of calcium cyanide, using one-fourth or one-half ounce, or whatever dosage in ounces is decided upon for each 1,000 cubic feet of air space.

(4) Place the chemical in a wide-mouthed bottle or other container and then scatter evenly on the soil and along the center walk or path, beginning at the far end and working toward the door. Be careful that none of the material comes in contact with the plants. For

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larger houses divide the material equally and scatter on two or more walks, depending on the size of the house. In such cases it is advisable to have an operator for each path.

(5) Close the doors for the night and post warning signs, and stay out of the greenhouse during the period of fumigation.

(6) Fumigation should preferably begin one hour after sunset and may continue until the following morning, at which time the house should be thoroughly aired before the sunlight strikes the plants. Very little gas remains in the ordinary type of greenhouse after overnight fumigation.

Precautions.—Temperature, humidity, moisture, light, and high winds influence the action of the gas and injury to plants. Temperature during fumigation should range from 60° to 70° F. If it falls below 55°, condensation of moisture on the foliage may increase the risk of injury, and a high temperature is also undesirable. Atmospheric moisture is an important factor in releasing hydrocyanic-acid gas from calcium cyanide. Extremely high humidity increases the risk of injury. Do not water plants just prior to fumigation. Walks may be damp, but they should not be wet. Standing water should not be present. Scattering the material on wet walks causes complex reactions and less gas is released. Fumigate only after sunset and in the dark, also only on still nights. Do not fumigate a large range of houses alone.

Carbon Disulphide.—Use 4 to 6 pounds of carbon disulphide per 1,000 cubic feet of space to fumigate clothing in chests and trunks, infested with clothes moths or other insects. For grain in bins, use 1 pound to 100 bushels. The liquid may be sprinkled over the grain or placed in pans. The container should always be very tight. Expose for 12 hours or longer. *The vapor is very inflammable,* and great care should be exercised to avoid fire. Extinguish all fires, glowing embers, gas and oil lamps, electric lights, and every other form of flame or spark before fumigation. Electric motors or fans should not be running during the fumigation. Carbon disulphide should not be applied to corn in the bin or to other grain which is known to be heating spontaneously. Do not fumigate at temperatures below 65° F. Ant colonies may be destroyed by the injection of 1 to 3 ounces of carbon disulphide into the nest.

Carbon Tetrachloride.—Carbon tetrachloride is less poisonous to insects than carbon disulphide, but is not inflammable, and therefore may be employed where carbon disulphide can not. Use 8 to 12 pounds per 1,000 cubic feet of space, and see that the containers are tight. Expose for 12 hours or more at 70° F. or above.

Sulphur Dioxide.—Burn 1 to 2 pounds of sulphur per 1,000 cubic feet of space for moths, house flies, and other insects in rooms, and to treat greenhouses which are free of plants. The sulphur is placed on earthenware plates set in pans of water to reduce danger of fire. A few teaspoonfuls of denatured alcohol poured over the sulphur will aid in lighting it, or commercial sulphur candles may be used. The length of exposure is 18 to 24 hours. Sulphur-dioxide gas is injurious to certain colored fabrics and to wall paper, and will tarnish nickel and brass.

Naphthalene.—Effective against clothes moths when used at the rate of 1 pound to 6 to 10 cubic feet of space, provided the container is tight and kept closed.

Paradichlorobenzene.—Used for the peach borer and certain household insects. For the latter use like naphthalene.

Repellents

Bordeaux Mixture.—Bordeaux mixture is used as a repellent for flea beetles, potato leaf hopper, and slugs and snails.

Trapping Devices

Tree-Banding Materials.—Various homemade and proprietary sticky mixtures are employed in the form of bands placed around trees to prevent the ascent of caterpillars. For tender-barked trees, place the material on a strip of heavy paper encircling the trunk; for heavy-barked trees, apply directly.

Spray Machinery

For greenhouse plants, back yards, and small gardens up to one-half acre hand atomizers may be employed. Usually for such areas the compressed-air sprayer or bucket pump (3-gallon capacity) will be found efficient. The latter should be equipped with a flexible hose about 3 feet long and a 2-foot spray rod with an angle nozzle. For large trees use an 8 or 10 foot spray rod.

For farm gardens and orchards of one-half to 5 acres use a barrel pump (30 to 50 gallon capacity) mounted on a cart, sled, or wheelbarrow. These outfits may be equipped with one or two leads of hose (10 feet long), each with spray rod (2 feet for truck crops; 8 to 10 feet for trees), and an angle nozzle. Whirlpool or cyclone nozzles are generally employed.

For commercial plantings of 5 or more acres use power and traction sprayers (usually 100 to 200 gallon capacity). For truck crops these should be fitted with a boom, so that three nozzles discharge to each row, one directing the spray downward and one angle nozzle on each side of the row directed upward and inward. Booms are usually built to spray two to four rows at a time. For trees the outfit should furnish a pressure of 200 to 250 pounds and possess an agitator to keep the solution well mixed. For large trees the outfit should be equipped with a tower.

Dusting Machinery

For back-yard and ornamental plants and small gardens up to one-half acre use small bellows and plunger type of duster of 1-pound capacity.

For greenhouses, farm gardens, and orchards of one-half to 5 acres use bellows or fan type duster of about a 10-pound capacity. A flexible hose and discharge nozzle are generally recommended.

For areas over 5 acres use traction or gasoline power dusters with flexible nozzles arranged to direct the dust on the plants. Many new types of machine have been devised for cotton dusting. Consult the State extension entomologist of the Bureau of Entomology, United States Department of Agriculture, for the type best adapted to your locality.

Miscellaneous Control Measures

Worming Fruit Trees.—Borers infesting peach and apple trees are removed by "worming" the trees. Remove the earth from around the collar of the tree to a depth of 4 or 5 inches and scrape free of loose bark and dirt. The burrows of the borers may then be seen. With a knife, stiff wire, or other suitable tool remove the borers from their burrows, cutting as little of the sound bark as necessary and making all cuts along the grain of the wood. After worming replace the earth around the tree, mounding it up to a height of 8 or 10 inches.

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9. FERTILIZERS

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FERTILIZERS

GENERAL

Exports of fertilizer materials from United States in 1913, 1923, and 1924[1]

Commodities	1913[2]		1923		1924[3]	
	Tons	*Dollars*	*Tons*	*Dollars*	*Tons*	*Dollars*
Nitrogenous:						
Ammonium sulphate		(4)	153, 677	11, 117, 726	118, 367	6, 918, 598
Other nitrogenous material		(4)	13, 291	614, 814	4, 699	283, 154
Phosphates:						
High-grade hard rock	494, 200	4, 942, 000	194, 339	2, 477, 501	150, 746	1, 814, 194
Land pebble	777, 898	4, 577, 962	630, 565	3, 273, 006	656, 005	3, 209, 965
Other phosphate rock	794	4, 127	2, 647	21, 664	12, 022	96, 673
Superphosphates		(4)	42, 099	534, 446	45, 751	588, 620
Prepared fertilizer mixtures		(4)	17, 997	832, 948	35, 793	1, 695, 472
Other fertilizers, n. e. s	74, 834	1, 875, 999	45, 073	1, 921, 972	44, 872	1, 900, 198
Total	1, 347, 726	11, 400, 088	1, 099, 688	20, 794, 077	1, 068, 255	16, 506, 874

[1] This table covers the total trade in the specified commodities.
[2] Fiscal year 1913, calendar years 1923 and 1924.
[3] Preliminary figures.
[4] Not especially enumerated. The trade (if any) is included in a group with other materials.

Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce.

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Imports of fertilizers into United States, 1913, 1923, and 1924[1]

Commodities	1913[2]		1923		1924[3]	
	Tons	*Dollars*	*Tons*	*Dollars*	*Tons*	*Dollars*
Nitrogenous:						
Calcium cyanamide			68, 532	3, 672, 398	75, 558	3, 687, 794
Calcium nitrate		(4)	9, 211	366, 340	7, 682	347, 304
Sodium nitrate	589, 136	20, 718, 968	891, 679	41, 955, 770	986, 608	47, 169, 496
Ammonium sulphate	54, 088	3, 655, 413	3, 539	204, 624	6, 000	342, 000
Guano	19, 075	340, 915		(4)	25, 245	754, 683
Dried blood		(4)		(4)	7, 191	403, 865
Tankage		(4)		(4)	23, 571	676, 201
All other materials		(4)	116, 563	3, 863, 467	47, 575	1, 085, 070
Phosphates:						
Bone phosphate	33, 337	801, 713	56, 336	1, 733, 005	22, 142	706, 727
Other phosphate materials		(4)	11, 010	149, 895	22, 886	257, 692
Potash:						
Muriate	201, 219	6, 782, 056	135, 497	4, 116, 180	128, 803	3, 972, 366
Sulphate, crude	42, 745	1, 753, 485	63, 578	2, 592, 921	75, 657	2, 856, 503
Kainite	466, 795	2, 154, 977	164, 161	956, 850	154, 954	913, 816
Manure salts	171, 802	1, 794, 058	269, 394	2, 939, 793	226, 144	2, 217, 974
Other potash-bearing substances		(4)	32, 826	412, 111	46, 461	479, 585
All other materials		3, 300, 833	35, 540	949, 468	38, 157	660, 419
Total	1, 578, 197	41, 302, 418	1, 857, 866	63, 912, 822	1, 894, 634	66, 531, 495

[1] This table covers the total trade in the specified commodities.
[2] Fiscal year 1913, calendar years 1923 and 1924.
[3] Preliminary figures.
[4] Not especially enumerated. The trade (if any) is included in a group with other materials.

Bureau of Foreign and Domestic Commerce, United States Department of Commerce.

Consumption

Following is the list of States showing the consumption of fertilizers for the fiscal years ended in 1909, 1914, 1919, and 1924, compiled from the most reliable statistics obtainable. In some States no accurate figures are available. For these States, indicated by an (*), estimates have been made, based on information obtained from State officials and fertilizer manufacturers:

Consumption of fertilizers in United States during fiscal years ended 1909, 1914, 1919, and 1924

State or Territory	Fiscal year ending—	1909	1914	1919	1924
		Tons	*Tons*	*Tons*	*Tons*
Alabama	Oct. 1	400, 000	592, 200	297, 903	472, 240
Arizona*	Dec. 31	----------	650	500	500
Arkansas	Sept. 30	25, 000	84, 850	64, 427	85, 000
California	June 30	40, 000	39, 471	43, 126	66, 273
Colorado*	Dec. 31	500	500	1, 000	500
Connecticut*	June 30	40, 000	74, 000	65, 000	78, 636
Delaware	July 1	20, 000	55, 000	30, 398	37, 150
Florida	Dec. 31	156, 340	240, 812	250, 613	365, 317
Georgia	---do----	807, 832	1, 282, 088	990, 919	678, 959
Idaho*	July 1	----------	500	500	800
Illinois*	Apr. 30	50, 000	40, 000	12, 000	14, 000
Indiana	Dec. 31	134, 064	219, 000	241, 000	189, 152
Iowa	Apr. 30	1, 500	4, 200	5, 000	3, 500
Kansas	Dec. 31	1, 095	9, 460	16, 937	4, 000
Kentucky	---do----	43, 000	83, 000	103, 000	85, 000
Louisiana	Aug. 31	83, 719	90, 588	97, 724	129, 288
Maine	Dec. 31	100, 000	168, 000	156, 000	182, 000
Maryland	---do----	142, 000	183, 350	174, 500	150, 000
Massachusetts	June 30	55, 000	54, 000	61, 000	61, 968
Michigan	Dec. 31	35, 000	60, 000	103, 264	94, 575
Minnesota	---do----	800	3, 800	5, 000	5, 000
Mississippi	Oct. 1	139, 884	127, 400	110, 000	316, 000
Missouri	Dec. 31	27, 701	65, 000	91, 000	49, 000
Montana*	No law.	----------	900	1, 000	500
Nebraska*	No law	100	500	500	500
Nevada*	No law.	----------	950	1, 000	500
New Hampshire*	Oct. 31	16, 000	20, 000	14, 000	16, 000
New Jersey	---do----	110, 000	155, 414	149, 485	152, 417
New Mexico*	No law.	----------	200	1, 500	500
New York*	Dec. 31	325, 000	420, 000	410, 000	375, 000
North Carolina	June 30	512, 716	872, 820	961, 238	1, 189, 314
North Dakota*	Dec. 31	----------	550	1, 000	500
Ohio	---do----	137, 000	203, 000	305, 236	357, 514
Oklahoma*	May 1	4, 000	29, 000	4, 000	3, 000
Oregon*	Dec. 31	1, 500	6, 300	7, 500	7, 500
Pennsylvania	---do----	275, 000	381, 900	340, 000	394, 458
Porto Rico*	June 30	11, 670	18, 164	21, 815	65, 643
Rhode Island*	Mar. 31	10, 000	12, 500	9, 000	9, 000
South Carolina	June 30	758, 363	1, 095, 728	1, 033, 887	881, 369
South Dakota*	July 1	----------	1, 000	3, 000	2, 000
Tennessee	June 30	54, 142	93, 550	109, 366	105, 417
Texas	Sept. 1	23, 800	77, 400	46, 000	126, 180
Utah*	Dec. 31	----------	1, 200	1, 000	500

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Consumption of fertilizers in United States during fiscal years ended 1909, 1914, 1919, and 1924—Continued

State or Territory	Fiscal year ending—	1909	1914	1919	1924
		Tons	*Tons*	*Tons*	*Tons*
Vermont*	June 30	17,000	18,000	18,000	18,000
Virginia	Dec. 31	323,644	437,808	421,484	441,890
Washington*	Mar. 31	1,250	2,400	4,000	3,000
West Virginia*	June 30	26,000	35,475	63,000	38,005
Wisconsin*	Dec. 31	1,500	4,500	10,000	15,000
Wyoming*	No law.		400	500	100
Totals		4,912,120	7,367,528	6,858,322	7,272,665
Hawaii	Dec. 31		80,000	71,000	100,000
Virgin Islands	June 30				5,000

Courtesy of American Fertilizer Handbook.

Valuation and Production

The Department of Commerce states that, according to the data collected at the biennial census of manufactures, 1923, the establishments engaged primarily in the manufacture of fertilizers reported products valued at $183,-088,751, an increase of 1.5 per cent as compared with 1921, the last preceding census year. The total for 1923 was made up of 7,237,164 tons of fertilizers, valued at $167,347,351, and other products, such as fish scrap, oil, grease, bone black, glue, sulphuric acid, and miscellaneous chemicals, to the value of $15,741,400.

Of the 573 establishments reporting for 1923, 122 were located in Georgia, 64 in North Carolina, 51 in Virginia, 48 each in Maryland and South Carolina, 38 in Alabama, 28 in Pennsylvania, 22 in Ohio, 17 each in Florida and New Jersey, 13 in Illinois, 12 in California, 11 in Indiana, 10 in Tennessee, and the remaining 72 in 21 other States. In 1921 the industry was represented by 588 establishments, the decrease to 573 in 1923 being the net result of the loss of 89 establishments which had been included for 1921 and the addition of 74 new establishments. Of the 89 establishments lost to the industry, 37 were idle during the entire year, 35 had gone out of business before the beginning of 1923, 7 had been engaged primarily in the manufacture of fertilizers in 1921 but reported other commodities as their principal products in 1923 and were therefore classified in the appropriate industries, and 10 reported products valued at less than $5,000 in 1923. (No data are tabulated at the biennial censuses for establishments with products under $5,000 in value.)

The southern district (the region lying south of the northern boundaries of North Carolina, Tennessee, Arkansas, and Oklahoma, and comprising in addition to the four States named, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas) reported 320 establishments for 1923, with a total production of 3,665,153 tons of fertilizers, or 50.6 per cent of the total for the industry. This percentage is comparable with 42.9 per cent for 1921, 52 per cent for 1919, and 57.4 per cent for 1914.

General statistics of fertilizer manufacture, 1923 and 1921

Item	1923	1921	Per cent of increase [1]
Number of establishments	573	588	−2.6
Wage earners (average number) [2]	18,572	16,898	9.9
Maximum month	(March) 30,707	(March) 26,745	
Minimum month	(June) 13,610	(July) 12,346	
Per cent of maximum	44.3	46.2	
Wages ... dollars	16,365,324	16,025,728	2.1
Cost of materials (including fuel and containers) ... dollars	127,980,450	144,978,255	−11.7
Products, total value ... dollars	183,088,751	180,374,789	1.5
Value added by manufacture [3] ... dollars	55,108,301	35,396,534	55.7
Horsepower	161,929	(4)	
Coal consumed (tons of 2,000 pounds)	202,641	(4)	

[1] A minus sign (—) denotes decrease.
[2] Not including salaried officers and employees or proprietors and firm members.
[3] Value of products less cost of materials.
[4] Not reported.

Detailed statistics of fertilizer products, 1923 and 1921

Item		1923 [1]	1921 [1]
Products, total	value	$183,088,751	$188,246,666
Fertilizers, total	tons	7,237,164	5,994,179
	value	$167,347,351	$174,878,864
Superphosphates [2]	tons	3,755,956	3,483,704
For sale [2]	tons	2,442,512	1,976,742
	value	$32,934,313	$33,598,364
Made and consumed	tons	1,313,444	1,506,962
Complete fertilizers	tons	3,804,324	2,985,265
	value	$110,189,780	$112,786,648
Ammoniated fertilizers	tons	188,682	339,222
	value	$5,647,545	$10,139,885
Commercial fertilizers (so-called)	tons	245,819	209,844
	value	$6,199,585	$5,207,052
Other fertilizers	tons	555,827	483,106
	value	$12,376,128	$13,146,915

[1] The figures for 1921 include data for fertilizers to the value of $7,817,861 manufactured as subsidiary products by establishments classified in other industries, and the product of 18 establishments with products valued at less than $5,000, aggregating $54,016. The figures for 1923 as given in this table relate only to the products of the fertilizer industry proper.
[2] Includes concentrated phosphates: 1923, 16,953 tons; 1921, 18,207 tons.

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Detailed statistics of fertilizer products 1923 and 1921—Continued

Item		1923	1921
Fish scrap	tons	76, 229	44, 670
	value	$2, 722, 688	$1, 720, 853
Oil, chiefly fish oil	gallons	5, 918, 053	2, 346, 632
	value	$2, 526. 171	$677, 886
Bone black	pounds	37, 487, 380	41, 238, 653
	value	$1, 870, 948	$3, 141, 631
Glue	value	$787, 483	$1, 248, 372
Grease	value	$571, 903	$370, 669
Sulphuric acid (basis 50° Baumé)	tons	1, 573, 658	1, 319, 582
For sale	tons	242, 456	175, 732
	value	$2, 006, 054	$1, 871, 911
Made and consumed	tons	1, 331, 202	1, 143, 850
All other products [3]	value	$5, 256, 153	$4, 336, 480

[3] Includes miscellaneous chemicals, pyrite cinder, poultry and stock feeds, etc.

Fertilizer manufacture: Summary for the United States, 1859 to 1923

Census year	Number of establishments	Wage earners (average number)	Primary horsepower	Capital	Wages	Cost of materials	Value of products	Value added by manufacture [1]
				1,000 dollars	*1,000 dollars*	*1,000 dollars*	*1,000 dollars*	*1,000 dollars*
1923	573	18, 572	161, 929	(2)	16, 365	127, 980	183, 089	55, 108
1921	588	16, 898	(2)	(2)	16, 026	144, 978	180, 375	35, 397
1919	600	26, 296	125, 939	311, 633	25, 363	185, 041	281, 144	96, 103
1914	784	22, 815	114, 281	217, 065	10, 532	107, 955	153, 196	45, 241
1909	550	18, 310	64, 711	121, 537	7, 477	69, 522	103, 960	34, 438
1904	399	14, 184	47, 989	68, 917	5, 127	39, 288	56, 541	17, 253
1899	422	11, 581	38, 680	60, 686	4, 185	28, 958	44, 657	15, 699
1889	390	9, 026	28, 240	40, 594	3, 418	25, 114	39, 181	14, 067
1879	364	8, 598		17, 914	2, 648	15, 595	23, 651	8, 056
1869	126	2, 501	2, 951	4, 396	767	3, 808	5, 815	2, 007
1859	47	308		466	95	591	891	300

[1] Value of products less cost of materials.
[2] Not called for on schedule for 1921.

FERTILIZER MATERIALS

General

Composition of the principal commercial fertilizing materials

Fertilizing material	Nitrogen	Phosphoric acid	Potash
	Per cent	*Per cent*	*Per cent*
Nitrate of soda	15.5 to 16.0		
Sulphate of ammonia	19.0 to 20.5		
Dried blood (high grade).	12.0 to 14.0		
Dried blood (low grade).	10.0 to 11.0	3.0 to 5.0	
Concentrated tankage	11.0 to 12.5	1.0 to 2.0	
Tankage (bone)	5.0 to 6.0	11.0 to 14.0	
Dried fish scrap	7.0 to 9.0	6.0 to 8.0	
Cottonseed meal	6.5 to 7.5	1.5 to 2.0	2.0 to 3.0.
Castor pomace	5.0 to 6.0	1.0 to 1.5	1.0 to 3.0.
Calcium cyanamide	19.0 to 22.0		
Ground bone (raw)	2.5 to 4.5	20.0 to 25.0	
Acid phosphate		12.0 to 16.0	
Basic slag		17.0 to 18.0	
Raw ground phosphate rock.		26.0 to 35.0	
Potassium sulphate			48.0 to 52.0.
Potassium muriate			48.0 to 52.0.
Kainite			12.0 to 12.5.
Kelp ash			30.0.
Nebraska potash salts			22.0.
Wood ashes		1.0 to 2.0	2.0 to 8.0.
Dried sheep manure	1.51 to 3.09	0.95 to 2.50	0.33 to 2.24.

Fertilizers: Conversion table

From—	To—	Multiply by—
Nitrogen	Ammonia	1.21
Ammonia	Nitrogen	.82
Nitrogen	Nitrate of soda	6.06
Nitrate of soda	Nitrogen	.16
Ammonia	Nitrate of soda	4.99
Nitrate of soda	Ammonia	.20
Phosphorus (P)	Phosphoric acid	2.30
Phosphoric acid (P_2O_5)	Phosphorus	.4366
Do	Bone phosphate of lime	2.18
Bone phosphate of lime	Acid phosphate (P_2O_5)	.45
Potassium chloride	Potash (K_2O)	.63
Do	Potassium (K)	.52
Potassium sulphate	Potash (K_2O)	.54
Do	Potassium	.45
Potash (K_2O)	Potassium (K)	.83
Potassium (K)	Potash (K_2O)	1.20
Ammonium sulphate	Nitrogen	.21
Do	Ammonia (NH_3)	.25
Calcium carbonate ($CaCO_3$, limestone).	Calcium (Ca)	.40
Calcium carbonate	Calcium oxide (CaO)	.56
Calcium oxide	Calcium (Ca)	.71
Calcium hydrate (slacked lime.	do	.54
Calcium hydrate	Calcium oxide	.75

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Mixed Fertilizers

The indiscriminate mixing of fertilizing materials is not a safe practice. This is mainly because of two facts: (1) When certain materials are mixed chemical changes take place which result in a loss of a valuable constituent, as when lime is mixed with guano nitrogen escapes, or in a change of a constituent, to a less available form, as when lime is mixed with superphosphates the phosphoric acid is made less soluble; and (2) mixtures of certain materials, as for example potash salts and Thomas slag, are likely to harden or "cake" and thus become difficult to distribute if kept some time after being mixed.

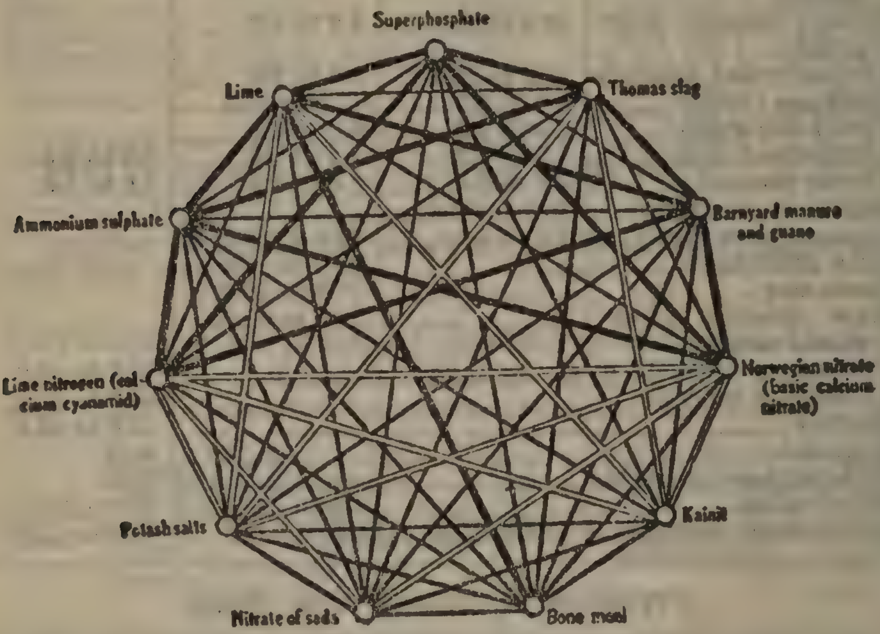

Diagram indicating what fertilizer materials may and may not be safely mixed. The dark lines unite materials which should never be mixed, the double lines those which should be applied immediately after mixing, and single lines those which may be mixed at any time.

Quantities of fertilizer ingredients to be used to give definite percentages in a ton of mixture.[1]

Ingredient	1 per cent	2 per cent	3 per cent	4 per cent	5 per cent
Nitrogen carriers (N):	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Nitrate of soda (15 per cent N)	133	266	400	532	666
Sulphate of ammonia (20 per cent N)	100	200	300	400	500
Cottonseed meal (7 per cent N)	285	571	856	1,142	1,428
Dried blood (10 per cent N)	200	400	600	800	1,000
Phosphoric-acid carriers (P_2O_5):					
Acid phosphate (12 per cent P_2O_5)	166	333	500	666	833
Acid phosphate (14 per cent P_2O_5)	142	285	428	571	714
Ground bone, raw [2] (23 per cent P_2O_5)	76	174	261	348	435
Potash carriers (K_2O):					
Potassium sulphate (50 per cent)	40	80	120	160	200
Potassium chloride (50 per cent)	40	80	120	160	200

Ingredient	6 per cent	7 per cent	8 per cent	9 per cent	10 per cent
Nitrogen carriers (N):					
Nitrate of soda (15 per cent N)	*Lbs.* 800	*Lbs.* 933	*Lbs.* 1,066	*Lbs.* 1,200	*Lbs.* 1,333
Sulphate of ammonia (20 per cent N)	600	700	800	900	1,000
Cottonseed meal (7 per cent N)	1,714	2,000			
Dried blood (10 per cent N)	1,200	1,400	1,600	1,800	2,000
Phosphoric-acid carriers (P_2O_5):					
Acid phosphate (12 per cent P_2O_5)	1,000	1,166	1,333	1,500	1,666
Acid phosphate (14 per cent P_2O_5)	856	1,000	1,142	1,285	1,428
Ground bone, raw [2] (23 per cent P_2O_5)	522	609	696	783	869
Potash carriers (K_2O):					
Potassium sulphate (50 per cent)	240	280	320	360	400
Potassium chloride (50 per cent)	240	280	320	360	400

[1] Where the combined materials do not total 2,000 pounds a filler may be used to bring up the mixture to that weight.
[2] Ground bone also carries nitrogen.

Example: To make up a 2:8:2 mixture, using acid phosphate, nitrate of soda, and potassium sulphate, use 266 pounds of nitrate of soda, 1,142 pounds of 14 per cent acid phosphate, 80 pounds of sulphate of potash, total, 1,488 pounds; make up total of 2,000 pounds with 512 pounds of ground limestone, dried peat, muck, or sand.

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Lime

The term lime, when used agriculturally, is generally applied to material used to supply calcium to the soil in the form of oxide, hydroxide, or carbonate. In the more restricted and accurate use of the term lime is oxide of calcium. The application of lime stimulates the proper decomposition of the organic matter in the soil, neutralizes acids in the soil, improves the physical condition of heavy soils, supplies lime to growing plants, or makes available other elements. The great majority of the soils of the East, South, and portions of the Central West are deficient in lime and may respond in increased yields to applications of lime.

Lime Materials.—Materials used for liming soils may be classified under the heads (1) calcium oxide, represented by burnt lime; (2) calcium hydroxide, represented by hydrated lime; (3) calcium carbonate, represented by limestone and marl; (4) miscellaneous waste products, containing varying proportions of calcium hydroxide and carbonate.

Burnt Lime.—Burnt lime is made by heating limestone or other forms of calcium carbonate (marble, oyster shells). Carbon dioxide (a gas) is driven off by this treatment, and calcium oxide (burnt lime) is left. This product may be marketed in several forms. If sold just as it comes from the kiln it may be known as "run of kiln," or sometimes as "agricultural lime." Agricultural lime is commonly used to indicate any form of lime used for soil improvement. For building or chemical trade the lime as it comes from the kiln is picked over by hand, all unburned or overburned pieces being taken out. Such lime naturally costs more, but even for agricultural purposes value is received in the better grade so obtained. The burnt lime, either before or after removal of impurities, may be ground and marketed as ground lime. A Federal statute provides that in interstate shipment a large barrel of lime shall weigh 280 pounds and a small barrel 180 pounds net. The weight of a bushel of lime is fixed by law in several States and varies from 72 to 80 pounds.

Hydrated Lime.—When calcium oxide (burnt lime) is treated with water chemical action takes place, water combines with the oxide, and calcium hydroxide is formed; and if the right quantity of water is added, a dry powder results. This is marketed for agricultural, building, and chemical trade as hydrated lime. In the manufacture of hydrated lime all unburned and overburned pieces are removed before the addition of water (slaking), and this removal of inert material and the fine powder resulting make commercial hydrated lime the highest grade of lime material available. Ordinary lump burnt lime can easily be converted into hydrated lime by the farmer, either by addition of water or if allowed to stand exposed to the air for a time.

Limestone.—Pure limestone is calcium carbonate with more or less impurities in the form of other minerals, usually silicates. When finely ground it is a valuable form of liming material, but to be immediately effective a fair proportion of the material should be very finely ground. Opinions differ as to how fine this should be or what proportion of this fine material is desirable or necessary, but a fair compromise between extremes is a specification requiring that at least 80 per cent should pass a 60-mesh sieve.

In the following table is shown the oxide of lime value of grades of carbonate (limestone) from 95 to 70 per cent and the oxide value of the material that will pass a 60-mesh sieve in the same grades:

Oxide of lime value of different grades of carbonate (limestone)

Carbonate of lime	Total oxide of lime per ton	Oxide of lime per ton where—			
		20 per cent passes 60-mesh sieve	40 per cent passes 60-mesh sieve	60 per cent passes 60-mesh sieve	80 per cent passes 60-mesh sieve
Per cent	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
95	1,064	213	425	638	851
90	1,008	202	403	605	806
85	952	190	391	571	761
80	896	179	358	538	716
75	840	168	336	504	675
70	784	157	313	470	627

The impurities in limestone have no value, and consequently low-grade stone should not be used for grinding. A stone containing 85 per cent carbonate may be considered high grade, whereas one containing only 60 per cent carbonate might not be worth the expense of quarrying, hauling, and grinding. Many limestones are mixtures of calcium and magnesium carbonates. When the magnesium carbonate is 10 per cent or more it is usually spoken of as magnesian or dolomitic limestone. The magnesium carbonate in a magnesian limestone is usually considered equal in value to calcium carbonate, and the stone is valued for liming purposes according to its total carbonate content.

Marl.—Marl is carbonate of calcium that has been deposited from water. It occurs frequently as a deposit under other material, such as clay or peat, or in beds of streams or lakes. It is usually in a finely divided condition, but sometimes the material has become cemented together and requires grinding before being suitable for agricultural use.

Miscellaneous.—Carbonate of lime is found in other forms in addition to limestone and marl. Coral consists of the skeleton remains of marine organisms and is essentially carbonate of lime. Deposits of coral are limited in the United States to Florida, but also occur in Hawaii. Where available, coral may be considered as having the same liming value as limestone of equal carbonate content. It usually requires grinding.

Oyster and clam shells, when cleaned of dirt and organic material, contain from 90 to 95 per cent of carbonate of lime. If finely ground they form a valuable liming material, and clean shells when burned furnish a high-grade lime. In many industries are waste products containing calcium oxide or carbonate that are suitable for agricultural use. Such products are lime from gas works, paper mills, tanneries, and water-softening plants; spent calcium carbide; and slags from iron and other works. Such products may contain compounds injurious to vegetation, and their freedom from such should be assured before they are used.

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Manures

Average composition of different farm manures, showing liquid and solid constituents

Kind of animal		Weight of manure	Nitrogen	Phosphoric acid	Potash
		Pounds	*Pounds*	*Pounds*	*Pounds*
Horse	Solid	1,632	8.0	4.84	3.9
	Liquid	368	4.3	Trace.	5.5
		2,000	12.3	4.84	9.4
Cow	Solid	1,457	4.6	2.98	2.16
	Liquid	543	5.1	1.14	5.15
		2,000	9.7	4.12	7.31
Hog	Solid	1,290	7.6	5.9	5.73
	Liquid	710	2.1	.89	7.07
		2,000	9.7	6.79	12.80
Sheep	Solid	1,200	7.6	5.47	2.74
	Liquid	800	5.04	.23	16.9
		2,000	12.64	5.70	19.64
Poultry		2,000	21.7	18.5	8.95

Percentages of nitrogen, phosphoric acid, and potash in fresh farm manures

Kind of manure	Nitrogen	Phosphoric acid	Potash
	Per cent	*Per cent*	*Per cent*
Horse, fresh, with straw	0.56	0.28	0.65
Cow, fresh, with straw	.45	.30	.43
Steer, fresh, with straw	.56	.35	.48
Hog	.66	.63	.48
Sheep, fresh, with straw	9.84	.45	.85
Poultry	9.02	.88	.48

REGULATORY WORK

State Fertilizer Control Officials

Alabama	Commissioner, department of agriculture and industries, Montgomery.
Arizona	No fertilizer law.
Arkansas	Commissioner, bureau of mines, manufactures, and agriculture, Little Rock.
California	Director, department of agriculture, Sacramento.
Colorado	No fertilizer law.
Connecticut	Director, agricultural experiment station, New Haven.
Delaware	Secretary, State board of agriculture, Dover.
Florida	State chemist, department of agriculture, Tallahassee.
Georgia	State chemist, department of agriculture, Atlanta.
Idaho	No fertilizer law.
Illinois	Director, department of agriculture, Springfield.
Indiana	State chemist, agricultural experiment station, La Fayette.
Iowa	Dairy and food commissioner, department of agriculture, Des Moines.
Kansas	Director, agricultural experiment station, Manhattan.
Kentucky	Director, agricultural experiment station, Lexington.
Louisiana	Commissioner, department of agriculture and immigration, Baton Rouge.
Maine	Commissioner, department of agriculture, Augusta.
Maryland	State chemist, University of Maryland, College Park.
Massachusetts	Director, agricultural experiment station, Amherst.
Michigan	Secretary, department of agriculture, Lansing.
Minnesota	Commissioner, dairy and food commission, St. Paul.
Mississippi	Commissioner, department of agriculture and commerce, Jackson.
Missouri	Director, agricultural experiment station, Columbia.
Montana	Director, agricultural experiment station, Bozeman.
Nebraska	Secretary, department of agriculture, Lincoln.
Nevada	No fertilizer law.
New Hampshire	Commissioner, department of agriculture, Concord.
New Jersey	State chemist, agricultural experiment station, New Brunswick.
New Mexico	No fertilizer law.
New York	Commissioner, department of farms and markets, Albany.
North Carolina	Commissioner, department of agriculture, Raleigh.
North Dakota	Director, agricultural experiment station, Agricultural College.

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Ohio	Chief, bureau of feed and fertilizers, department of agriculture, Columbus.
Oklahoma	Chief inspector, State board of agriculture, Oklahoma City.
Oregon	Chemist, agricultural college experiment station, Corvallis.
Pennsylvania	Secretary, department of agriculture, Harrisburg.
Rhode Island	Director, agricultural experiment station, Kingston.
South Carolina	Secretary, Clemson Agricultural College, Clemson College.
South Dakota	State food and drug commissioner, college of agriculture, Brookings.
Tennessee	Commissioner, department of agriculture, Nashville.
Texas	State chemist, agricultural experiment station, College Station.
Utah	No fertilizer law.
Vermont	Director, agricultural experiment station, Burlington.
Virginia	Commissioner, department of agriculture and immigration, Richmond.
Washington	Director, department of agriculture, Olympia.
West Virginia	Commissioner, department of agriculture, Charleston.
Wisconsin	Director, feed and fertilizer division, department of agriculture, Madison.
Wyoming	No fertilizer law.

MISCELLANEOUS

Fertilizer constituents in different materials

Material	Nitrogen	Phosphoric acid	Potash
	Per cent	*Per cent*	*Per cent*
Alfalfa hay	2.45	0.50	2.10
Apple skins (ash)		3.08	11.74
Banana skins and stalk (ash)		2.34 to 3.25	41.76 to 49.40
Barley, grain	1.75	.75	.50
Bat guano	1 to 12	2.5 to 16	
Beet roots	.25	.10	.50
Brigham tea (ash)			5.94
By-product from silk mills	8.37	1.14	.12
Cana tree (ash)			15.65
Cantaloupe rinds (ash)		9.77	12.21
Castor-bean pomace	5 to 6	2 to 2.5	1 to 1.25
Cat-tail reeds and water-lily stems	2.02	.81	3.43
Cat-tail seed	.98	.39	1.71
Coal ash, anthracite		.1 to .15	.1 to .15
Coal ash, bituminous		.4 to .5	.4 to .5
Cocoa-shell dust	1.04	1.49	2.71
Coffee grounds	2.08	.32	.28
Coffee grounds, dried	1.99	.36	.67
Corncobs, ground, charred			2.01
Corncobs (ash)			50.00
Corn, grain	1.65	.65	.40
Corn, green forage	.30	.13	.33
Cottonseed	3.15	1.25	1.15
Cottonseed hulls (ash)		7 to 10	15 to 30
Cotton waste from factory	1.32	.45	.36
Cowpeas, green forage	.45	.12	.45
Cowpeas, seed	3.10	1.00	1.20
Crab, common	1.95	3.60	.20
Cucumber skins (ash)		11.28	27.20
Dried mussel mud	.72	.35	
Eggs	2.25	.40	.15
Eggshells, burned		.43	.29
Feathers	15.30		
Field beans, seed	4.00	1.20	1.30
Field beans, shells	1.70	.30	.35
Fire-pit ash from smoke-houses			4.96
Fish scrap, red snapper and grouper	7.76	13.00	.38
Fish scrap, fresh	2 to 7.5	1.5 to 6	
Fresh-water mud	1.37	.26	.22
Garbage rubbish (New York City)	3.4 to 3.7	1 to 1.47	2.25 to 4.25
Garbage tankage	1 to 2	.5 to 1	.5 to 1
Greasewood (ash)			12.61
Garden beans, seed and pods	.25	.08	.30
Gluten feed	4 to 5		
Greensand		1 to 2	5.00
Grapes, fruit	.15	.07	.30
Grapefruit skins (ash)		3.58	30.60
Ground bone, burned		34.70	
Hair	12 to 16		
Harbor mud	.99	.77	.05
Hoof meal and horn dust	10 to 15	1.5 to 2	
Kentucky blue grass, hay	1.20	.40	1.55

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Fertilizer constituents in different materials—Contd.

Material	Nitrogen	Phosphoric acid	Potash
	Per cent	*Per cent*	*Per cent*
King crab, dried and ground	10.00	0.26	0.06
King crab, fresh	2 to 2.5		
Leather, acidulated	7 to 8		
Leather, ground	10 to 12		
Leather, scrap	6.88		
Leather, scrap (ash)		2.16	.35
Lemon culls, California	.15	.06	.26
Lemon skins (ash)		6.30	31.00
Limekiln ash		.5 to 1	.1 to 2.00
Lobster refuse	4.50	3.50	
Milk	.50	.30	.18
Mussels	.90	.12	.13
Molasses residue in manufacture of alcohol	.70		5.32
Oak leaves	.80	.35	.15
Oats, grain	2.00	.80	.60
Olive pomace	1.15	.78	1.26
Olive refuse	1.22	.18	.32
Orange culls	.20	.13	.21
Orange skins (ash)		2.90	27.00
Peanuts, seed or kernels	3.60	.70	.45
Peanut shells	.80	.15	.50
Peanut shells (ash)		1.23	6.45
Pea pods (ash)		1.79	9.00
Picker dirt from cotton mill	1.37	.68	1.56
Pigweed, rough	.60	.16	
Potatoes, leaves and stalks	.60	.15	.45
Potatoes, tubers	.35	.15	.50
Potato skins, boiled sweet (ash)		3.29	13.89
Potato skins, raw white (ash)		5.18	27.50
Poudrette	1.46	3.68	.48
Powder-works waste	2 to 3		16 to 18
Pumpkin, flesh	.16	.07	.26
Pumpkin, seed	.87	.50	.45
Rabbit brush (ash)			13.04
Ragweed, great	.76	.26	
Red clover, hay	2.10	.50	2.00
Redtop, hay	1.20	.35	1.00
Residuum from raw sugar	1.14	8.33	
Rhubarb, stems	.10	.04	.35
Rock and mussel deposits (sea)	.22	.09	1.78
Rockweed	1.90	.25	3.68
Roses, flowers	.30	.10	.40
Sagebrush (ash)			4.10 to 5.42
Salt-marsh hay	1.10	.25	.75
Salt mud	.40		
Saltpeter waste	.52 to 3.3		5.6 to 13.7
Sardine scrap	7.97	7.11	
Seaweed (Atlantic City, N. J.)	1.68	.75	4.93
Shoddy and felt	4 to 12		

Fertilizer constituents in different materials—Contd.

Material	Nitrogen	Phosphoric acid	Potash
	Per cent	*Per cent*	*Per cent*
Shoddy dirt from woolen mills	4.40	0.20	0.68
Shrimp heads, dried	7.82	4.20	
Shrimp waste	2.87	9.95	
Siftings from oyster-shell mound	.36	10.38	.09
Silkworm cocoons	9.42	1.82	1.08
Soot from chimney flues [1]		1.05	.35
Spanish moss	.60	.10	.55
Spent mash of distilleries	1.40		
Starfish	1.80	.20	.25
String beans, strings, stems (ash)		4.99	18.03
Sunflower, seed	2.25	1.25	.79
Sweet potatoes	.25	.10	.50
Tanbark (ash)		.24	.38
Tanbark, spent (ash)		1.5 to 2	1.5 to 2.5
Tea grounds	4.15	.62	.40
Tea leaves (ash)		1.60	.44
Timothy, hay	1.25	.55	1.00
Tobacco, leaves	4.00	.50	6.00
Tobacco, stalks and stems	2.50 to 2.70	.65 to .90	4.5 to 7
Tomatoes, fruit	.20	.07	.35
Tomatoes, leaves and stalks	.35	.10	.4 to .5
Waste from felt-hat factory	13.80		.98
Waste from hares and rabbits	7.00	1.7 to 3.1	.60
Waste gunpowder (sweepings from mill)	10.28		34.50
Waste product from paint manufacture	.028	39.50	
Waste silk	8 to 11		
Wheat, bran	2.65	2.90	1.60
Wheat, grain	2.00	.85	.50
Wheat, straw	.50	.15	.60
White sage (ash)			13.77
Wood ash, leached		1 to 1.5	1 to 3
Wood ash, unleached		1 to 2	4 to 10
Wool waste	5 to 6	2 to 4	1 to 3

[1] Soot usually contains an average of 3 per cent nitrogen.

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.42 Legumes.
.420 General.
.421 Alfalfa.
.422 Clover, red.
.423 Clover (other than red).
.4231 Alsike.
.4232 Bur.
.4233 Crimson.
.4234 Mammoth.
.4235 White.
.4239 Miscellaneous.
.424 Cowpea.
.425 Field peas.
.426 Lespedeza or Japan clover.
.427 Sweet clover (melilot).
.4271 Annual white (*Melilotus alba var. annua*).
.4272 Annual yellow (*Melilotus indica*).
.4273 Biennial white (*Melilotus alba*).
.4274 Biennial yellow (*Melilotus officinalis*).
.4279 Miscellaneous.
.428 Soy bean.
.429 Miscellaneous.
.4291 Kudzu.
.4292 Mung bean.
.4293 Peanut.
.4294 Velvet bean.
.4295 Vetches.
.43 Millets.
.430 General.
.431 Japanese or barnyard (*Echinochloa crusgalli edulis*).
.432 Italian or foxtail (*Chaetochloa italica*).
.4321 Common.
.4322 German.
.4323 Hungarian.
.4324 Kursk.
.4325 Siberian.
.4329 Miscellaneous.
.433 Pearl millet or penicillaria (*Pennisetum glaucum*).
.434 Broomcorn millet, proso, or hog millet (*Panicum miliaceum*).
.435 Ragi or finger millet (*Eleusine coracana*).
.439 Miscellaneous.
.44 Meadows.
.45 Pastures.
.450 General.
.451 Kinds.
.4511 Permanent.
.4512 Rotation or short-lay.
.4513 Temporary.
.4514 Tame.
.4515 Wild.
.4519 Miscellaneous.

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.4 Forage crops—Continued.
  .45 Pastures—Continued.
    .452 Regions.
      .4521 Northern humid.
      .4522 Pacific humid.
      .4523 Southern humid.
      .4524 Western range.
      .4529 Miscellaneous.
    .459 Miscellaneous.
  .46 Root crops.
    .460 General.
    .461 Artichoke.
    .462 Carrot.
    .463 Mangel.
    .464 Turnip.
    .469 Miscellaneous.
  .47 Sorghums.
    .470 General.
    .471 Durra or "gyp-corn."
    .472 Feterita.
    .473 Hegari.
    .474 Kafir.
    .475 Kaoliang.
    .476 Milo.
    .477 Shallu.
    .478 Sorgo.
    .479 Miscellaneous.
  .48 Silage.
  .49 Miscellaneous.
    .491 Sunflower.
.5 Oil crops.
  .50 General.
  .51 Banana.
  .52 Castor bean.
  .53 Coconut.
  .54 Corn. (See .2.)
  .55 Cotton. (See .3.)
  .56 Flax. (See .2.)
  .57 Peanut. (See .4.)
  .58 Soy bean. (See .4.)
  .59 Miscellaneous.
.6 Root and tuber crops. (See 12.31 and 10.4.)
  .60 General.
  .61 Artichoke.
  .62 Beet.
  .63 Carrot.
  .64 Mangel.
  .65 Potato.
  .66 Rutabaga.
  .67 Sweet potato.
  68 Turnip.
  .69 Miscellaneous.
.7 Rubber crops.
  .70 General.
  .71 Apocynaceæ.
  .72 Euphorbiaceæ.
  .73 Guayule.
  .74 Urticaceæ.
  .79 Miscellaneous.
.8 Sugar and sirup crops.
  .80 General.
  .81 Corn.
  .82 Sorgo (sweet sorghum).
  .83 Sugar beet.
  .84 Sugar cane.
  .85 Sugar maple.
  .86 Sugar palm.
  .89 Miscellaneous.
.9 Miscellaneous.

FIELD CROPS

GENERAL

Imports of forage-plant seeds,[1] *1921–1924*

Kind of seed	1924	1923	1922	1921
	Pounds	*Pounds*	*Pounds*	*Pounds*
Alfalfa	12, 818, 400	8, 784, 000	7, 259, 100	941, 600
Blue grass:				
Canada	816, 000	835, 700	1, 034, 100	1, 148, 200
Kentucky	----------	----------	----------	----------
Brome grass, awnless	----------	----------	14, 000	8, 600
Clovers:				
Alsike	11, 056, 000	5, 566, 100	7, 056, 500	4, 121, 200
Crimson	7, 744, 500	2, 262, 200	3, 442, 900	5, 565, 900
Red	24, 728, 900	447, 900	10, 391, 200	16, 333, 300
White	1, 407, 500	519, 600	1, 622, 800	515, 500
Clover mixtures:				
White and alsike	[2] 74, 000	13, 500	36, 300	1, 600
Red and alsike	----------	----------	3, 800	8, 300
Alsike and timothy	----------	6, 600	6, 600	13, 200
Timothy, alsike, and white	----------	----------	----------	----------
Fescue, meadow	300	----------	500	----------
Millet:				
Broomcorn	595, 200	5, 360, 900	1, 496, 000	152, 300
Foxtail	184, 200	65, 300	301, 900	13, 700
Mixtures:				
Grass	100	100	43, 100	5, 700
Spring vetch and oats	----------	----------	----------	4, 000
Orchard grass	603, 400	768, 000	2, 921, 700	----------
Rape	6, 600, 200	6, 384, 100	4, 762, 600	4, 244, 700
Redtop	400	11, 400	1, 700	200
Rye grass:				
Perennial	1, 951, 600	1, 834, 100	1, 867, 700	1, 523, 200
Italian	1, 033, 900	859, 500	828, 300	576, 600
Timothy	100	32, 000	95, 100	390, 500
Vetch:				
Hairy	3, 214, 900	1, 599, 100	1, 940, 900	1, 386, 600
Spring	1, 209, 600	1, 858, 100	344, 600	542, 400

[1] Permitted entry under the seed importation act.
[2] This includes all clover mixtures.

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Location of seed-testing laboratories

State	City	Location
Arizona	Tucson	Agricultural experiment station.
Arkansas	Little Rock	Department of agriculture.
California	Sacramento	State department of agriculture.
Colorado	Fort Collins	Agricultural experiment station.
Connecticut [1]	New Haven	Do.
Delaware	Dover	State board of agriculture.
District of Columbia.	Washington	U. S. Department of Agriculture.
Idaho	Boise	State capital.
Indiana	La Fayette	Agricultural experiment station.
Illinois	Springfield	Department of agriculture.
Iowa	Ames	Agricultural experiment station.
Kansas	Manhattan	Do.
Kentucky	Lexington	Do.
Louisiana	Baton Rouge	Department of agriculture and immigration.
Maine	Orono	Agricultural experiment station.
Maryland	College Park	Do.
Massachusetts [1]	Amherst	Do.
Michigan	Lansing	State department of agriculture.
Minnesota	St. Paul	University farm, agricultural experiment station.
Missouri	Columbia	Agricultural experiment station.
Montana	Bozeman	Do.
Nebraska	Lincoln	Department of agriculture.
New Jersey	New Brunswick	Agricultural experiment station.
New Hampshire	Durham	Do.
New Mexico	State College	Do.
New York	Geneva	Do.
North Carolina	Raleigh	Department of agriculture.
North Dakota	Agricultural College.	Agricultural experiment station.
Ohio	Columbus	Department of agriçulture.
Oklahoma	Oklahoma City	Board of agriculture.
Oregon	Corvallis	Agricultural experiment station.
Pennsylvania	Harrisburg	Department of agriculture.
South Carolina	Columbia	Do.
South Dakota	Brookings	Agricultural experiment station.
Tennessee	Nashville	Board of agriculture.
Texas	Austin	State board of agriculture.
Utah	Salt Lake City	State crops and pests commission.
Vermont	Burlington	Agricultural experiment station.
Virginia	Richmond	Department of agriculture.
Washington	Olympia	Do.

[1] Does not have laws regulating the sale of seeds.

Location of seed-testing laboratories—Continued

State	City	Location
West Virginia	Charleston	Experiment station, department of agriculture.
Wisconsin	Madison	Department of agriculture.
Wyoming	Laramie	Agricultural experiment station.
Canada	Calgary, Alberta	Do.
Canada	Guelph, Ontario	Ontario experiment station.
Canada	Ottawa, Ontario	Department of agriculture.
Canada	Winnipeg, Manitoba.	Manitoba experiment station.

Rates of seeding for cereals

Crop	North Atlantic States	North Central States	Southern States	Great Plains and Rocky Mountain and Pacific States	
				Dry-farm areas	Humid and irrigated areas
	Pounds per acre	*Pounds per acre*	*Pounds per acre*	*Pounds per acre*	*Pounds per acre*
Barley	72 to 96	72 to 96	72 to 96	36 to 72	72 to 120
Buckwheat	36 to 60	36 to 60			
Corn	7 to 10	7 to 10	6 to 8	5 to 8	7 to 10
Flax		20 to 30		15 to 25	
Oats	64 to 96	64 to 96	48 to 96	48 to 80	64 to 128
Rice			65 to 100	90 to 120	
Rye	70 to 100	70 to 100	42 to 84		
Sorghums, grain				2 to 5	
Wheat, spring	75 to 120	75 to 120		45 to 90	90 to 150
Wheat, winter	75 to 120	75 to 120	75 to 105	30 to 75	75 to 120

The North Atlantic States include those from Maine southward to Maryland and Virginia; the North Central States, those from Michigan, Ohio, and Kentucky westward to the eastern edge of the Great Plains, including eastern Kansas, eastern Nebraska, and eastern North and South Dakota; the Southern States, those from Virginia southward and westward to eastern Oklahoma and eastern Texas; and the Great Plains and Rocky Mountain and Pacific States, the remainder of the United States.

In the humid areas rates of seeding for the small grains may vary within wide ranges without material changes in yields. In general, sowing less than the lowest rate shown in the table will result in decreased yields, and no increase will be obtained from sowing more than the highest rate. On the dry farms in the Great Plains and Rocky Mountain and Pacific States

the rate of seeding varies largely with rainfall, less seed being sown where the rainfall is light. With corn and the grain sorghums, which are usually planted in rows about 3½ feet apart, the rates given are sufficient to obtain the desired stands in plants per acre. With corn the rate of planting necessarily varies widely with the size of kernel, the size of stalk, and the productiveness of the land. Corn in the South usually is planted rather thickly and thinned to the desired stand.

Pasture mixtures for the Northeastern States

	Pounds
Well-drained land:	
Kentucky blue grass	8
Orchard grass	8
Redtop	3
White clover	2
Wet land:	
Redtop	6
Meadow fescue	6
Alsike clover	4

Pasture mixtures for the South

	Pounds
Well-drained bottom land:	
Bermuda grass	2
Lespedeza	10
Sandy coastal plain:	
Carpet grass	5–10
Dallis grass	3
Lespedeza	5

For irrigated pastures in the West a mixture commonly known as Morton's mixture, consisting of brome grass 9 pounds, orchard grass 9 pounds, timothy 4 pounds, meadow fescue 5 pounds, and yellow sweet clover 3 pounds, is recommended.

For the nonirrigated, high-altitude pastures of the West that have a rainfall of 20 inches or more, a combination of brome grass, timothy, and yellow sweet clover is usually most satisfactory.

Average purity and germination tests of best commercial grade of seed and commonly accepted weight per bushel

Kind of seed	Purity	Germination	Weight per bushel
	Per cent	*Per cent*	*Pounds*
Red clover	99.4	92.4	60
Alsike clover	98.3	91.5	60
White clover	96.9	90.8	60
Crimson clover	98.2	91.2	60
Sweet clover (hulled)	98.9	89.6	60
Bur clover (unhulled)			10
Lespedeza	93.9	82.1	25
Alfalfa	99.5	91.4	60
Timothy	99.6	93.5	45
Redtop [1]	93.2	90.5	14
Orchard grass	86.9	86.6	14
Kentucky blue grass [2]	83.0	78.3	14
Bermuda grass	91.5	77.9	35
Brome grass (*Bromus inermis*)	87.7	91.8	14
Meadow fescue	97.8	91.2	22–24
Italian rye grass	97.9	83.5	24
Perennial rye grass	97.9	83.6	24
Hairy vetch	98.7	89.0	60
Spring vetch	98.7	92.3	60
Golden millet	98.8	92.9	50
Common millet	98.0	93.5	50
Siberian millet	97.9	92.7	50
Hungarian millet	97.5	92.4	48–50
Japanese millet	96.4	88.9	32–35
Broomcorn millet	99.3	92.1	50
Amber sorgo	97.9	88.2	50
Orange sorgo	97.9	88.5	50
Sumac sorgo	98.3	90.5	50
Sudan grass	98.0	91.1	32
Kafir	98.1	91.3	56
Milo	97.7	91.2	56
Feterita	97.9	91.1	56
Rape	99.2	91.8	50
Wheat	98.8	94.4	60
Corn (field) [3]	99.3	94.0	56
Barley	98.2	93.5	48
Oats	98.6	95.0	32
Rye	97.8	91.8	56
Flax	98.5	87.3	56
Buckwheat	98.6	92.7	48–52
Cotton	98.0	85.0	30–32
Cowpeas	96.1	91.4	60
Canada field peas	99.3	94.8	60
Soy beans	98.7	93.8	60

[1] Fancy recleaned, solid redtop seed weighs 30 to 38 pounds or more per measured bushel.
[2] Fancy recleaned Kentucky blue grass seed weighs 19 to 28 pounds or more per measured bushel.
[3] Shelled.

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Normal sources of seed supply

Group of States	Grasses			Clovers and alfalfa			Millets		
	From own farm	From other farms	From dealers	From own farm	From other farms	From dealers	From own farm	From other farms	From dealers
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Eastern	5	2	93	6	3	91	3	1	96
Southern	6	4	90	11	5	84	12	6	82
Central	23	12	65	30	18	52	20	11	69
Northern	69	13	18	18	16	66	13	10	77
Far Western	4	2	94	12	9	79	7	3	90

Group of States	Forage sorghums			Small grains		
	From own farm	From other farms	From dealers	From own farm	From other farms	From dealers
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Eastern	1	0	99	44	12	44
Southern	36	13	51	45	15	40
Central	25	12	63	76	15	9
Northern	5	5	90	78	14	8
Far Western	16	18	66	59	15	26

Import duties on seeds under the tariff acts of 1922 and 1913

Kind of seed	Unit	Rate of duty	
		1922 act	1913 act
Field seeds:		*Cents*	*Cents*
Alfalfa	Pound	4	Free.
Alsike clover	do	4	Free.
Crimson clover	do	1	Free.
Red clover	do	4	Free.
White clover	do	3	Free.
Clover, n. s. p. f.	do	2	Free.
Millet	do	1	Free.
Timothy	do	2	Free.
Hairy vetch	do	2	Free.
Spring vetch	do	1	Free.
All other grass seed, n. s. p. f.	do	2	Free.
Sugar beet		Free.	Free.
Rape		Free.	Free.

Import duties on seeds under the tariff acts of 1922 and 1913—Continued

Kind of seed	Unit	Rate of duty	
		1922 act	1913 act
Vegetable seeds:		*Cents*	*Cents*
Beet (except sugar)	Pound	4	3
Cabbage	do	10	6
Canary	do	1	½
Cauliflower	do	25	Free.
Celery	do	2	Free.
Kale	do	6	6
Kohl-rabi	do	8	6
Mangel wurzel	do	4	Free
Mushroom spawn	do	1	1
Onion	do	15	----------
Parsley	do	2	3
Parsnip	do	4	3
Pepper	do	15	10
Radish	do	4	3
Spinach	do	1	1
Turnip	do	4	3
Rutabaga	do	4	3
Flower	do	6	Free.
All other vegetable and field seeds, n. s. p. f.	do	6	5
Oil-bearing seeds:			
Castor bean	do	½	3/16
Flax	Bushel	40	20
Poppy	100 lbs	32	[1] 15
Sunflower	Pound	2	Free.
Soy bean	do	½	Free.
Cotton	do	⅓	Free.
Rape	----------	Free.	Free.
Hemp	----------	Free.	Free.
Sesame	----------	Free.	----------
Peanut—			
Shelled	Pound	4	¾
Unshelled	do	3	⅜

[1] 15 cents per bushel of 47 pounds, equivalent to approximately 32 cents per 100 pounds.

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ALKALOIDAL AND OTHER DRUG CROPS

Cassena

Shrublike plant which grows wild in profusion in the South Atlantic and Gulf States. Its leaves when properly cured resemble yerba maté or Paraguayan tea, millions of pounds of which are consumed annually in South American countries, especially Argentina and Chile. The technological processes of utilizing cassena have been developed to a high degree of efficiency. A delightful beverage, flavoring sirup, and concentrated extract can be made from the cured leaves. The extract has been used as a flavor in the manufacture of ice cream.

Ginseng

Fleshy-rooted herbaceous plant native of this country and formerly of frequent occurrence in shady, well-drained situations in hardwood forests from Maine to Minnesota and southward to the mountains of Georgia and the Carolinas. It has long been valued by the Chinese for medicinal use, though rarely credited with curative properties by natives of other countries. When placed under cultural conditions, ginseng should be shielded from direct sunlight by the shade of trees or by lath beds. The soil should be fairly light and well fertilized with woods earth, rotted leaves, or with fine rawbone meal applied at the rate of 1 pound to each square yard. Seed should be planted in the spring as early as the soil can be worked to advantage, placed 6 inches apart each way in the permanent beds or 2 by 6 inches in seed beds, and the seedlings transplanted to stand 6 to 8 inches apart when 2 years old. Only cracked or partially germinated seed should be used.

Ginseng needs little cultivation, but the beds at all times should be kept free from weeds and grass and the surface of the soil slightly stirred whenever it shows signs of caking. A winter mulch over the crowns is usually essential, but it should not be applied until freezing weather is imminent and should be removed in the spring before the first shoots come through the soil. The roots do not reach marketable size until about the fifth or sixth year from seed. When dug they should be carefully washed or shaken free from all adhering soil, but not scraped. Curing is best effected in a well-ventilated room heated to about 90° F. Nearly a month is required to cure properly the larger roots, and great care should be taken to prevent molding or souring. Overheating must also be avoided. When well cured the roots should be stored in a dry, airy place until ready for sale. A market may be found with the wholesale drug dealers, some of whom make a specialty of buying ginseng roots for export. The wholesale price of cultivated ginseng roots, as quoted October 1, 1926, ranged from \$8 to \$12 a pound, according to quality and freedom from disease. Ginseng production is a minor industry which affords an opportunity for profit to only a limited number of judicious growers.

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Goldenseal

Native perennial, formerly plentiful in open woodlands having ample shade, natural drainage, and an abundance of leaf mold. Its range is from southern New York and Ontario west to Minnesota and south to Georgia and Kentucky. When goldenseal is grown under cultivation the soil should be well fertilized, preferably by decaying vegetable matter, such as woods soil and rotting forest leaves, which should be well worked in to a depth of 10 inches or more. Rawbone meal and cottonseed meal are also favorable in their action. Seed may be sown in October in a well-prepared seed bed. It may be scattered broadcast or dropped one-half inch apart and covered with fine leaf mold to the depth of 1 inch. During the winter the seed should be protected with burlap or fertilizer sacks and should also be guarded against encroachment of moles or mice. Plants may be set 6 to 8 inches apart each way and the rootstocks covered to a depth of about 2 inches. For satisfactory growth goldenseal requires about 75 per cent of shade during the summer, which should be provided by a lath shade or by cloth, brush, or vines. The soil should be kept free from weeds and the plants liberally watered throughout the growing season, but good drainage is necessary since goldenseal does not thrive in boggy ground. Under favorable conditions it reaches its best development in about five years from seed, or in a year or two less when grown from root buds or by divisions of the rootstocks. The roots are dug in the fall after the tops have withered. They are washed clean of all soil and dried on lath screens in an airy place in mild sunlight or partial shade, or indoors on a clean, dry floor. When dried in the open they should be protected from rain and dew. The cured root is kept in loose masses until marketed, since close packing may cause attacks of mold. The dried leaves and stems of goldenseal, commonly known as "seal herb," are also a marketable product. The wholesale price of the root, as quoted October 1, 1926, was $5 per pound.

Hops

Can be grown generally throughout the United States, but at present its commercial production is practically restricted to areas situated in the States of Oregon, California, New York, and Washington. Small quantities are raised in Wisconsin, Idaho, Massachusetts, Pennsylvania, Michigan, Vermont, Kentucky, and Ohio. Produced most successfully in the milder regions where abundant early rainfall is followed by warm dry weather as the crop approaches maturity. Rich alluvial lands or deep sandy or gravelly loams are preferred for hop raising.

Hop plants may be raised from the seeds, but the simplest method of growing is from root cuttings, also called "roots" or "sets." In California planting should be done in January or February, although in some seasons planting as late as May 1 has yielded good results. In Oregon and Washington hops are planted in March or April and in New York in April. In California practically all new hops are now set out in rows at a distance of 6½ to 7 feet apart each way. When set 6½ feet apart there will be 1,031 hills to the acre and 42¼ square feet of soil to the plants of each hill; when set 7 feet apart there will be 889 hills per acre and 49 square feet of soil to the plants of each hill. In Oregon and Washington, where two horses are used in cultivating, the distance between the rows is usually 8 feet, requiring

about 680 plants per acre. Begin cultivating early and continue until the plants are well armed out. By the process of pruning the excess shoots from the rootstock are removed, and the formation of fewer but at the same time stronger vines is favored.

Except in the hop-growing regions of New York the use of hop poles has been largely discontinued. The hops are healthier on strings, more successfully sprayed, mature earlier, are usually richer and brighter, arm out lower, and are not so leafy. Also they can be picked cleaner and are much more easily torn down for picking. Dry, cure, and bale for market. Hops are baled in jute bagging, 16 threads or less to the inch. About 5 running yards are required for each bale. This weighs from 7½ to 10 pounds, and for it 5 pounds tare is allowed in selling.

Peppermint

Perennial of the mint family, frequently found growing wild in moist situations throughout the eastern half of the United States. It is cultivated on a commercial scale, chiefly on the muck lands of southern Michigan and northern Indiana. The volatile oil forms the principal marketable product, but there is some demand in the crude drug trade for the dried leaves and flowering tops. The plant is propagated from "roots" or runners, which should be set in an almost continuous row in furrows about 3 feet apart and covered to a depth of about 3 inches. It can be grown on any land that will produce good crops of corn, but is most successful on the muck lands of reclaimed swamps. On uplands it soon exhausts the soil and will not do well for more than two or three seasons without the rotation of crops. On rich muck lands it will grow for a number of years, the soil being plowed after the crop is harvested and the runners turned in to form a new growth the succeeding year. Keep the ground free from weeds, since their presence in the crop at harvest will seriously injure the quality of oil.

Fertilizer is rarely needed for peppermint grown on muck soil, but on uplands plow in 12 or more tons per acre of rotted stable manure before planting. Similar applications may be made between the rows in early spring and plowed in as the land shows signs of exhaustion. Commercial truck or potato fertilizers cultivated in between the rows at the rate of 600 pounds to the acre have proved useful in keeping up fertility, but manure is to be preferred, as it provides humus or vegetable matter as well as increases the fertility. Harvest in July or August, when the plants are in full bloom. The crop is cut and cured like hay. When fairly well dried it is placed in large vats or stills having a capacity of 1 to 3 tons of dry material and is distilled with steam to obtain the oil. The average yield is about 30 pounds of oil per acre.

Tobacco

General.—Tobacco acreage constituting about one-half of 1 per cent of the acreage devoted to all crops and the value of the crop is about 3 per cent of that of all farm crops. Census figures show that tobacco is grown in 42 States, in 1,694 counties, and on 448,572 farms. Tobacco culture is largely localized in a comparatively few States, and in several States extensive culture is limited to only a few counties. The three States—Kentucky, North Carolina, and Tennessee—produce nearly two-

thirds of the total output of the country, and Kentucky alone produces a third of the total. Lancaster County, Pa., is the leading county in the United States in acreage and production, and Hartford County, Conn., the second in production, leads in the value of her crop.

Classes and Types.—Tobacco is manufactured into various forms for consumption, but large quantities also are exported in an unmanufactured state. The three general classes are (1) cigar tobaccos, (2) export tobaccos, and (3) manufacturing tobaccos. By manufacturing tobaccos are meant all types used in manufactures other than cigars. The manufacturing and export classes have much in common as regards cultural methods, and some types are used both for manufacturing and export. Each of these three classes may be subdivided into types, depending on their special uses, methods of growing and curing, or on the variety of seed used. The cigar tobaccos have three principal types, corresponding to the three parts of the cigar—wrapper leaf, binder leaf, and filler leaf. In the manufacturing and export tobaccos are such types as the flue-cured, Virginia sun-cured, White Burley, and dark fire-cured. These are produced on special kinds of soil and according to definite methods of growing, curing, and handling the crop. The variety of seed used may also be an important factor.

Cigar tobaccos.—Three important varieties or groups are used in growing cigar tobaccos in this country: (1) Broadleaf or Seedleaf group, (2) Havana Seed group, and (3) Cuban group. The typical Broadleaf or Seedleaf is the Connecticut Broadleaf, extensively grown in the Connecticut Valley for wrappers. Acclimated strains of this variety have been developed and are grown in all the northern cigar-leaf States for the production of binder and filler leaf, each strain being given the name of the State in which it is grown, like Pennsylvania Broadleaf. The Connecticut Havana, or Havana Seed, also is extensively grown in the Connecticut Valley for wrapper and binder-leaf purposes, and in other northern cigar-tobacco districts for binder leaf, and to some extent for filler leaf. The so-called Spanish varieties, extensively grown for binder and filler purposes, are closely related to or identical with the Havana Seed. Zimmer Spanish, principally grown for filler in the Miami Valley of Ohio, and Comstock Spanish, chiefly grown for binder leaf in Wisconsin, are the two most important members of this group. Zimmer Spanish as grown in Ohio is markedly different in quality from Connecticut Havana as grown in New England, but when the two are grown side by side they look alike.

Another variety of some local importance in the Miami Valley of Ohio is known as Little Dutch, of which there are several strains. This variety, which relatively is narrow-leaved, is thought to have been introduced from Germany. The Cuban group is composed of strains or selections obtained from imported seed. Seed imported from Cuba is usually found to be composed of several distinct subvarieties. The Cuban is the only variety of much importance in the southern cigar-tobacco districts, where it is grown both for wrappers and for fillers, although the Sumatra variety formerly was extensively grown for wrapper leaf. In the Connecticut Valley a considerable acreage of Cuban tobacco for the production of wrapper leaf is grown under an artificial shade of cloth. The principal wrapper-leaf sections are the Connecticut Valley and the area centering around Gadsden County, Fla., and Decatur County, Ga. Wisconsin is typically a binder-producing State. The Big Flats

district of New York and Pennsylvania also produces mainly a binder leaf. Most cigar-filler leaf is produced in the Lancaster, Pa., district and the Miami Valley district of Ohio.

Export and manufacturing tobaccos.—White Burley is a distinctive variety, producing a type of cured leaf known by the same name, practically all of which is used in domestic manufacture. This variety, of which there are several subvarieties, such as the Stand-up and Twist Bud, is grown mainly in north-central Kentucky, southern Ohio, southwestern West Virginia, and southeastern Indiana. Aside from its peculiar chlorotic appearance, Burley more closely resembles the cigar-seedleaf group than the other export and manufacturing varieties (except the Maryland). The Maryland is another fairly distinctive variety, in many respects resembling the cigar-seedleaf and White Burley varieties. The type of leaf produced is known as Maryland tobacco. Two subvarieties of the Maryland are known as Broadleaf and Narrowleaf, respectively. In the production of the remaining types of export and manufacturing tobaccos, such as the flue-cured and fire-cured, a very large number of so-called varieties are used more or less interchangeably. Nearly all of these may be regarded as coming under two principal groups—Orinoco and Pryor—although the distinctions between many of the strains or subvarieties are so slight as to make it impossible to determine in which of the two groups each really belongs. Of the Orinoco group may be mentioned the Big Orinoco, Little or Narrowleaf Orinoco, White-Stem Orinoco, Lizard Tail, Gooch, and Flanagan. Among the group of Pryors are the Blue Pryor, Yellow Pryor, White or Medley Pryor, and Silky Pryor. Two additional varieties or subvarieties of the export and manufacturing tobaccos of importance are the Yellow Mammoth and One Sucker.

White Burley is used primarily for domestic manufacture of chewing and smoking tobaccos and cigarettes. The dark fire-cured and air-cured types of western Kentucky, northwestern Tennessee, and central Virginia are largely exported, but also are employed in the production of chewing and pipe-smoking tobaccos. The flue-cured tobacco of southern Virginia, North Carolina, eastern South Carolina, and southern Georgia is a leading cigarette, pipe-smoking, and chewing type, and also exported in large quantities. The product of southern Maryland has long been an export type, but more recently is being used in increasing quantities in the manufacture of cigarettes and smoking tobaccos.

Tobacco in the Farming System.—Grown as a cash crop and has a relatively high value per acre. The average tobacco acreage per farm runs 4 to 5 acres in the principal producing districts. In the highly specialized cigar-wrapper district of New England the average is about 8 acres. Tobacco acreage represents about 11 per cent of the total improved land on tobacco farms in Virginia, 17 per cent in North Carolina, 8 per cent in Kentucky, and 28 per cent in Connecticut. The average yield of tobacco is about 800 pounds per acre. The labor requirements are large, especially at certain seasons of the year, and this is an important factor in determining the tobacco acreage of the individual farms.

Sharply contrasting systems of cropping tobacco lands are found in different regions. The tobacco-producing districts of Connecticut, Pennsylvania, Maryland, and North Carolina represent two regions of high yields and two of low yields. In Connecticut tobacco is grown mostly on light sandy and sandy loam soils, which are

not naturally fertile. Since the average farm is rather small, tobacco ordinarily must be grown each year on the same land. In this instance rapid development of the plant to large size is essential for success, and to accomplish this result growers make exceedingly heavy applications of commercial fertilizers and liberal use of barnyard manure and lime. The high yields of the Lancaster, Pa., district are obtained under a wholly different farming system. A well-balanced cropping system is practiced, which includes the growing of wheat, grass, and clover, and corn in rotation with tobacco. The winter feeding of steers is an important feature of this system.

In both the Maryland export and the North Carolina flue-cured districts soils which are naturally rather infertile are commonly used for tobacco. In Maryland much land available for tobacco culture remains untilled each year. The prevailing practice has been to grow two or more crops of tobacco on the land, mostly without manure or fertilizer, sometimes with an intervening crop of wheat. A crop of corn may then follow, after which the land remains idle for a period of years in order that the productiveness may be restored. In the North Carolina tobacco district there is no systematic rotation of crops as a general practice. The rule has been an alternation of continuous cropping to tobacco and resting the land for one or more years, thus resembling the practice in Maryland. Fertilizers are much more generally and more liberally used than in Maryland.

Climate.—Important factor in the general distribution of tobacco culture in the United States and affects especially the quality of the crop. The general tendency in northern latitudes is toward the production of a large, relatively thin leaf that has no pronounced aroma. Thus northern climatic conditions favor the production of cigar types possessing these leaf characteristics of large size, thinness, and weak aroma. In the southern districts the tendency is toward the production of somewhat smaller, more aromatic leaf of heavier body, as seen in the cigarette, pipe-smoking, chewing, and export types.

Soils.—The cigar wrapper and binder types of the Connecticut Valley and of the Quincy, Fla., districts are grown on sandy loam soils containing but little clay in the subsoil and having a low water-holding capacity. The cigar binder-leaf soils of Wisconsin are sandy soils, loams, and light clay loams, but the cigar-filler soils of Pennsylvania and Ohio are silt and clay loams, the Pennsylvania soils being largely of limestone origin. The filler soils are considerably heavier and have a greater water-holding capacity than the binder-leaf soils. Burley attains its highest development in the very fertile phosphatic limestone soils of the blue-grass region of Kentucky and in southern Ohio. The dark fire-cured and air-cured tobaccos of Kentucky, Tennessee, and Virginia are grown largely on heavy silt and clay loams having a high water-holding capacity. The flue-cured type is grown on gray sandy and sandy-loam soils of low natural fertility. The body and texture of the flue-cured leaf depend largely on the texture of the subsoil on which it is grown. The cigarette and granulated pipe-smoking grades are obtained chiefly on the lighter soils where but little clay is in the subsoil, but the plug-filler and wrapper grades are obtained on somewhat heavier soils having more clay in the subsoil.

Fertilizers.—Not ordinarily necessary to apply commercial fertilizers to the Burley tobacco crop. In Pennsylvania and Wisconsin barnyard manure is widely used in lieu of commercial fertilizers, and in the Connecticut Valley both manure and fertilizers are commonly used.

In nearly all remaining tobacco-growing districts much reliance is placed on commercial fertilizers. This is particularly true of the bright flue-cured districts. The rate of applying fertilizers ranges from 1 to 2 tons per acre in the Connecticut Valley, from 600 to 1,000 pounds in the bright flue-cured districts and the cigar-tobacco district of Ohio, and from 300 to 500 pounds in most of the dark fire-cured and air-cured districts. The so-called complete fertilizers are commonly used. Cigar tobaccos require rather heavy applications of nitrogen, but the dark fire-cured and air-cured types and Burley require somewhat lower percentages. For the bright flue-cured leaf only the minimum quantity of nitrogeneous fertilizer required for proper growth of the plant is used. Phosphoric acid is usually applied in quantities in excess of actual requirements for growth in order to promote proper ripening. Liberal applications of potash are usually profitable because of favorable action on the quality of the tobacco. Under certain conditions magnesia is an important constituent of the fertilizer. Lime may be beneficial or injurious, depending on soil conditions and the type of tobacco.

Miscellaneous

Belladonna.—Sometimes called "deadly nightshade." It is a large, poisonous perennial that occurs wild in Europe, where it also is cultivated. Both the leaves and the roots are important crude drugs. In recent years it has been cultivated in California, Michigan, Indiana, Pennsylvania, and New Jersey, but is likely to winterkill in the colder sections. May be propagated in a small way from cuttings of the young shoots rooted in moist sand in the usual manner or from divisions of the fleshy rootstocks made early in the spring. It is most readily grown from seeds which may be sown singly in pots or well-drained boxes in a cool greenhouse in midwinter, or in a sheltered place in a garden early in the spring. Transplant the seedlings singly to small pots, or handle in the same manner as tomato or other vegetable plants that are intended for field planting. As soon as the danger of frost is past transplant to the field and set about 20 inches apart in rows 30 or more inches apart. Belladonna thrives best in deep, moist, well-drained loam containing lime, such as will under proper fertilization produce good garden vegetables. Prepare the seed bed by plowing deep, either in the fall or early spring, and repeat working with the disk or spring-tooth harrow and smoothing harrows. Good commercial fertilizers, such as are commonly used in truck gardens, are beneficial. Stable manure at the rate of 12 to 20 tons to the acre may be used if plowed under when the ground is prepared. Pick the leaves when the plants are in full bloom. Handle carefully to avoid bruising, and dry in the shade in order to retain the green color. A hundred pounds of fresh leaves yield about 18 pounds when well dried. One crop only can be collected the year of planting, but two crops are gathered in each of the next two or three years, after which it appears better to market the roots and make new plantings. Although only the leaves should be collected for the best pharmaceutical trade, the young growth, including the smaller sappy twigs, has medicinal value and may be sheared from the plants and dried in the same manner as the leaves The roots alone are not so profitable as the leaves. The best roots are those of the second or third year's growth, and are harvested in the fall after

frost, the tops being removed and raked off and the roots turned out with a deep-running plow, or with a potato fork if the area is small. Wash and cut into about 4-inch lengths and split the larger pieces lengthwise to aid in drying. Dry either in the sun or with mild artificial heat. On October 1, 1926, the leaves were quoted at 19 to 22 cents a pound and the roots at 17 to 18 cents.

Henbane.—Poisonous annual or biennial herb of the nightshade family, introduced into this country from Europe and occasionally found as a weed in a number of the Northern States. The leaves, flowering tops, and sometimes the seeds are used medicinally. It is propagated from seeds; but when these are sown in the open field germination is uncertain, and a very poor stand or total failure is a frequent result. Germination is usually much more certain when the seeds are sown under glass, but the plants do not readily stand transplanting and often die after they are set in the open. Very good results have been obtained from seed sown in small pots under glass in January, the seedlings being transferred to 3-inch pots in March and transplanted in May to the field, where the plants were set at least 15 inches apart in the rows. The soil requirements and method of cultivation are practically the same as for belladonna. The potato beetle attacks this plant. Ordinarily the plants blossom about August of the second year and die after ripening their seed, but individual plants started early frequently bloom and set seed the first year. The leaves and flowering tops are collected when the plants are in full bloom and are carefully dried in the shade. The yield under favorable conditions is estimated at about 600 pounds per acre. The wholesale price on October 1, 1926, was 19 to 20 cents.

CEREAL CROPS

Barley

General.—Ranks fourth in importance among the cereal crops of the United States, being exceeded in value by corn, wheat, and oats. The average annual production is about 193,000,000 bushels. Much barley is grown outside the regions where corn and oats do well and furnishes a grain feed for livestock. Was introduced by the early Dutch and English settlers into the Atlantic coast colonies and by the Spaniards into Mexico and the Pacific coast.

Climate and Soil.—In the South, winter barley finds very favorable climatic conditions in the mountain areas, especially in eastern Kentucky and Tennessee. In the North some winter barley is produced around the Great Lakes, especially in Michigan. In New York two-rowed barley can be grown with success. The entire northern Plains constitute an area especially suited to the culture of two-rowed barleys, but the extreme southern Plains are more suited to hooded sorts, as are certain localities of high altitude in the Rocky Mountain region. Several counties in northwestern Kansas have a climate unusually favorable to barley production. The Great Basin has features peculiar to itself and distinct from California. Barley is sensitive to soil variation. It demands a well-drained soil, but does not thrive on sands. Porous soils are preferred. With drainage or light rainfall, heavy soils produce good crops. Clay loams are good. Barley is a cool-weather plant.

Rotation.—Barley does best after a cultivated crop. Corn, followed by barley (seeded with grass), which in turn is followed by hay or pasture, is the best rotation for the humid districts. If barley is grown for two years, it should be sown at a lesser rate the second year, so as to make a better nurse crop. Potatoes, where grown, occupy the same place as corn in the scheme of rotation. Field peas may take the place of corn in the regions where they are grown, the rotation being peas, wheat, and barley. Much of the barley west of the ninety-eighth meridian is grown without definite rotation. In the South winter barley occupies the same place as wheat.

Fertilizer.—Barnyard manures in the humid-spring region should be applied to the previous crop, as they induce lodging when applied to barley. The use of commercial fertilizers at present is almost limited to the Eastern and Southern States. A fertilizer approaching a 3–10–3 formula is satisfactory.

Seed Bed.—Fall plowing in the humid-spring region, disked corn ground in the Great Plains, and summer-fallow in regions west of the Rocky Mountains are the best methods of preparation.

Seeding.—Good seed of a good variety, well matured, well cleaned, and free from weed seeds and diseases is essential. Early seeding is necessary to get maximum returns. In the northern Plains the loss from seeding delayed beyond April 25 is more than 1 per cent a day. Use 2 bushels per acre in the humid sections. The rate decreases with the decrease in rainfall. Use 3 or 4 pecks per acre in the driest sections.

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Depth of Seeding.—Varies from 1½ inches in the humid regions to 2½ or 3 inches in the Great Basin.

Method of Seeding.—Drilling with a grain drill is the best method.

Harvesting.—Barley should be mature when harvested, but should not be allowed to stand until the losses from shattering become important. The varieties of the humid region and Great Plains shatter more than those of the arid regions. Use a grain binder in cutting the grain. The combined harvester is cheaper to operate, but the losses are greater. Shock and stack so as to allow the least weather damage possible.

Utilization.—Manufactured into pearled barley, breakfast food, and flour. From 15 to 80 per cent of barley flour can be mixed with wheat flour, depending upon the kind of bread to be baked. Makes a good stock feed, may be fed whole, but is better rolled or coarse ground.

Varieties.—In present practice each of the three regions has a predominant variety that succeeds well throughout that region. These are the Coast in the arid region, the Manchuria and Oderbrucker in the humid-spring region, and the Tennessee Winter in the humid-winter region. Of the less widely grown varieties, the Hannchen does well almost anywhere, but seems particularly adapted to the middle Plains. In Montana and Wyoming the Horn is superior, and in the southern Plains the Horsford. In the Great Basin, in addition to the Coast variety, the Club Mariout and the Hannchen are promising. In California, besides the Coast, the Club Mariout is useful for late seeding. Under irrigation the Trebi is the outstanding variety in the Great Basin.

Best varieties of barley, listed in order of yield, based on results obtained during five-year period, 1917–1921 [1]

Place	First variety	Second variety	Third variety
Storrs, Conn.	Wisconsin Pedigree.	Oderbrucker	O. A. C. 21.
Ithaca, N. Y.	Oderbrucker (Sel.).	Manchuria	Oderbrucker (Sel.).
State College, Pa.	Charlottetown 80.	Lion	Michigan.
Wooster, Ohio	Ohio Winter	Texas Winter	Michigan Winter.
East Lansing, Mich.	Crawford (Sel.)	Crawford (Sel.)	Gold.
La Fayette, Ind.	Lion	Manchuria	Oderbrucker.
Urbana, Ill.	Wisconsin Pedigree.	Oderbrucker	Horsford.
De Kalb, Ill.	Oderbrucker	Wisconsin Pedigree.	Lion.
Madison, Wis.	O. A. C. 21	Oderbrucker (Sel.).	Oderbrucker (Sel.).
St. Paul, Minn.	Minsturdi	Manchuria	Aker.
Waseca, Minn.	Manchuria	Hybrid	Minsturdi.
Duluth, Minn.	Svansota	French Chevalier.	Manchuria.
Grand Rapids, Minn	Minsturdi	Manchuria	French Chevalier.
Crookston, Minn.	do	do	Samofa.

[1] From "Tests of Barley Varieties in America."

Best varieties of barley, listed in order of yield, based on results obtained during five-year period, 1917–1921—Continued

Place	First variety	Second variety	Third variety
Morris, Minn	Manchuria (Sel.).	Manchuria (Sel.).	Manchuria (Sel.).
Ames, Iowa	Oderbrucker (Sel.).	Oderbrucker (Sel.).	O. A. C. 21.
Columbia, Mo	Sandrel	Trebi	Featherston.
Fargo, N. Dak	Manchuria (Sel.).	Manchuria (Sel.).	Lion.
Edgeley, N. Dak.	Oderbrucker (Sel.).	Manchuria	Oderbrucker (Sel.).
Mandan, N. Dak.	White Smyrna	Svanhals	Hannchen.
Dickinson, N. Dak.	Steigum	White Smyrna	Hanna.
Williston, N. Dak.	Hanna	Oderbrucker	Hannchen.
Brookings, S. Dak.	Odessa	Manchuria	Gatami.
Eureka, S. Dak	do	White Smyrna	Hannchen.
Highmore, S. Dak.	do	White Smyrna (Sel.).	White Smyrna (Sel.).
Cottonwood, S. Dak.	do	White Smyrna	Gatami.
Newell, S. Dak. (dry land).	White Smyrna	Coast	Do.
Newell, S. Dak. (irrigated).	Trebi	Chevalier II	Hannchen.
Lincoln, Nebr	Club Mariout	Ace	O. A. C. 21.
North Platte, Nebr.	Trebi	McClymont	Coast.
Mitchell, Nebr	do	Barbary	Svanhals.
Manhattan, Kans.	Manchuria (Sel.).	Manchuria (Sel.).	Wisconsin Winter.[1]
Hays, Kans	Club Mariout	Coast	Gatami.
Colby, Kans	Odessa	Ellis	Coast.
Garden City, Kans.	White Smyrna	Odessa	Do.
Tribune, Kans	Coast	Ellis	Odessa.
Havre, Mont	Horn	Bohemian	Goldfoil.
Moccasin, Mont.	Hannchen	White Smyrna	Meloy.
Huntley, Mont	Trebi	do	Chevalier II.
Sheridan, Wyo	White Smyrna	Trebi	Svanhals.
Archer, Wyo	Sandrel	Horn	Trebi.
Fort Collins, Colo.	Coast	Hanna	Gold.
Akron, Colo	Smyrna	White Smyrna	Coast.
Sandpoint, Idaho.	Han River	do	Baker.
Moscow, Idaho	Winter Club	Michigan Winter.	Peruvian.
Aberdeen, Idaho (irrigated).	Trebi	Beldi Giant	Sandrel.
Aberdeen, Idaho (dry land).	White Smyrna	do	Club Mariout

[1] Fall-sown.

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Best varieties of barley, listed in order of yield, based on results obtained during five-year period, 1917–1921—Continued

Place	First variety	Second variety	Third variety
Nephi, Utah	Bulgarian [3]	Turkestan [3]	Tennessee Winter.[2]
Pullman, Wash.	Winter Club [2]	Wisconsin Winter (Sel.)[2]	Wisconsin Winter (Sel.)[2]
Lind, Wash.	Coast	Meloy	Horsford.
Moro, Oreg.	Club Mariout	Peruvian	Peru.
Union, Oreg.	Trebi	Horn	White Smyrna
Burns, Oreg. (dry land).	White Smyrna	Hannchen	Coast.
Burns, Oreg. (irrigated).	Hannchen	White Smyrna	Winter Club.[3]
Newlands, Nev.	Coast	Trebi	Hannchen.
Chico, Calif.	Club Mariout	Poda	Beldi Dwarf.
Davis, Calif.	Coast (Sel.)	Beldi Giant	Coast (Sel.).
Arlington, Va.	Orel	Wisconsin Winter.	Pidor.
Blacksburg, Va.	Union Winter	Virginia Selection (Sel.).	Virginia Selection (Sel.).
Athens, Ga.	Turkestan	Tennessee Winter.	Wisconsin Winter.
Knoxville, Tenn.	Union Winter	do	Beardless 20.
Jackson, Tenn.	do	Beardless 20	
State College, N. Mex.	Tennessee Winter.	O. A. C. Sel. 7	Coast.

[2] Fall-sown. [3] Spring-sown.

Standards.—(See also 2.041.) For the purposes of the official grain standards of the United States, barley shall be any grain which consists of 50 per cent or more of barley and contains not more than 25 per cent of cereal grains of a kind or kinds other than barley. The term barley in the standards shall not include hull-less barley. Barley for the purposes of the standards is divided into classes and subclasses as follows: (1) Barley; (2) western barley—divided into subclasses (*a*) bright western and (*b*) western; 3 two-rowed—divided into subclasses (*a*) bright two-rowed and (*b*) two-rowed; (4) black barley; and mixed barley. Barley grown west of the Great Plains area of the United States is inspected and graded on a "dockage" basis. Barley grown east of the Rocky Mountains is inspected and graded under a system of grading which does not provide for "dockage."

Buckwheat

Buckwheat does not belong to the grass family, and therefore is not truly a cereal. It is grown, however, for the making of flour for human consumption and hence is a cereal substitute. The United States is the third largest buckwheat-producing country in the world, being surpassed by Russia and by France. However, it is a comparatively unimportant crop in this country. It grows best where the climate is moist and cool, being well adapted to New York, Pennsylvania, Ohio, Michigan, Wisconsin, New England, and to the mountainous sec-

tions of Maryland, West Virginia, Virginia, Kentucky, North Carolina, and Tennessee. Buckwheat is not usually included in a definite rotation. It is suited to light, well-drained soils, such as sandy loams, and to the silt-loam soils. On very poor soil that has not been well farmed, 100 to 300 pounds per acre of a complete fertilizer furnishing some nitrogen and potash, but principally phosphorus, is recommended. Three varieties are commonly grown in this country—the Japanese, the Silver-hull, and the Common Gray. Sowing is general in New York, Pennsylvania, and Michigan from June 24 to July 1. Seed at the rate of 3 or 4 pecks per acre is required. It may be sown with a grain drill or may be broadcast and harrowed in. For harvesting, a cradle or scythe is often used on account of the rough land on which the crop is grown, although many farmers use the ordinary binder. The crop may be threshed either with a flail or by machinery. The yield varies, being usually between 15 and 30 bushels per acre. Buckwheat is valuable also as a weed destroyer, as a soil renovator, as a summer cover and green-manure crop, and as a source of honey for bees.

Corn

General.—Grown in every State of the Union, it reaches its true preeminence in the Corn Belt, that strip of productive land stretching from Ohio westward to Missouri and beyond. It exceeds any other crop in acreage, production, value, and multiplicity of uses. Its value is greater than the combined values of wheat and cotton.

Soil.—For the highest and most profitable yields, corn requires a fertile, well-drained, loamy soil well supplied with humus that can be easily worked with labor-saving machinery. However, it is produced on soil types ranging from sand to heavy clay.

Climatic Factors.—Rainfall and length and temperature of the growing season are important. Corn growing is limited toward the north by the low temperatures and by the short growing season, which is under 120 days in the average year along the Canadian border. Along the gulf it is 240 days or over. Most of the Corn Belt has an average growing season of 140 to 150 days. Comparatively little corn is grown for grain where the season is less than 140 days. Some of the southern varieties require as much as 180 days from planting to maturity, whereas some of those grown in the North will mature in less than 90 days of good growing weather. Corn requires high temperatures both night and day during the growing season. Practically no corn is grown where the mean summer temperature is less than 66° F., or where the average night temperature during the three summer months falls below 55° F.

Fertilizer.—The use of fertilizers, formerly confined to the Eastern and Southern States, is increasing in the Corn Belt, as profits from their use become apparent. Build up the productivity of the soil by rotation and by the supplemental use of phosphates or potash when required. Barnyard manure that is well decomposed and moist can be applied abundantly. Corn on clover sod frequently gives high yields. It often may be desirable to fertilize for corn either by the use of mixed fertilizers applied in the row or by the application of nitrate of soda from time to time during the development of the plant. The exact practice must be determined by local conditions.

Planting.—Corn planting begins in the usual year about February 1 in extreme southern Texas and at progres-

sively later dates toward the North. The northward advance is at an average rate of 13 miles a day, until by May 1 planting has generally begun in central Nebraska, north-central Illinois, and central Ohio. During the next 10 days it begins in practically all regions where corn is grown northward to the Canadian line. Throughout the Corn Belt planting is general about May 15 and is completed usually before June 1. In New York and northern and eastern Wisconsin it is general the last week in May. In any locality it may continue for two weeks or longer. In the South there is often a second or late planting, usually in June, after the planting and chopping of cotton are completed. Rows 4 to 5 feet apart are more profitable throughout the South. A distance of 3.3 feet between corn rows is suggested for most localities in the North. Some two-row planters are more easily adjusted to 3 feet 4 inches, which is very satisfactory. May be either drilled in the row, checked, or listed. Plant corn 1½ to 3 inches deep, the shallow planting for heavy soils and early planting, and the deeper for loose soils and late planting. Planting usually should be deep enough to put the seed in moist soil, if possible.

Cultivation.—Harrows, weeders, or disk cultivators adjusted to throw the soil from the corn rows should be used before the corn is up or is large enough to be worked with other implements. The best experimental data available indicate that the prime requisite of cultivation is that it shall prevent weed growth. Shallow cultivation therefore should be given often enough to keep the field free from weeds.

Seed Selection.—Corn yields can be increased by the use of better seed. Select seed corn in the field from stalks which yield best in equal competition with others. The variety should be one which succeeds well and matures under local conditions. Gather ears as soon as they are ripe and before any freezing has occurred. Go through the field with a picking bag on the shoulder and select drooping ears that shed rain readily, but not ears which have broken or rotted shanks. Avoid ears on stalks that are leaning or broken or that are smutty or otherwise diseased. By walking between two corn rows one can readily find the good high-yielding plants. In the South select ears which are well protected from insects by a long, tight shuck covering. In both the Central and Southern States, where stalks have a tendency to grow too tall, select short, thick stalks producing pendent ears at or below their middle point. Where exceedingly early maturing varieties are necessary, select seed from stalks that produce their ears high enough to keep them from touching the ground when they become pendent. In prolific varieties, i. e., varieties bearing two or more ears per stalk, all the ears on a stalk are of equal value for seed.

Drying and Caring for Seed.—Immediately after gathering, place the seed ears to dry in a position where they will not touch one another and where there is a good circulation of air. Binder twine or some of the commercial hangers are satisfactory means of suspending ears to dry. In the Southern States it is not desirable to leave the ears where they are likely to be injured by insects any longer than necessary to dry. When the seed becomes as dry as old corn, take it from the racks, weigh it, and store it where moisture, moths, or mice can not injure it. An upstairs room or an attic usually offers good protection from moisture. A pound of naphthalene or moth balls stored with each bushel of seed ears will protect it from grain moths and do it no injury. Boxes or crates completely covered with fly screening or woven wire will give protection from mice and rats.

Testing the Seed.—Seed corn that matured normally and has been properly preserved will grow satisfactorily. Make a seed-corn testing box or rag-doll tester, and test 100 ears separately. Be sure that each kernel tested is perfect in appearance and was not injured at the tip when removed from the ear. If 3 or more kernels out of 10 from any ear fail to grow it will be advisable to test every ear before planting. If the seed has been properly selected and preserved, the 100 ears tested will seldom reveal any poor ones, and further testing of the supply will be unnecessary.

Rag-Doll Tester.—The rag-doll tester has proved to be one of the most convenient and satisfactory forms. It is also one of the least expensive testers. Use bleached muslin, cut into strips 16 inches wide and from 3 to 5 feet long. With a pencil or crayon draw a line down the center of the strip. Leaving at least 4 inches at the ends, mark the strip crosswise every 4 inches, and then number the sections. Moisten the tester before putting the kernels upon it. Number the ears and place them in definite order. From different places on ear No. 1 take out 10 kernels and place them in section No. 1. Similarly, take 10 kernels from ear No. 2, place them in section No. 2, and continue in this manner until every section of the tester has been filled. Care should be taken to place the kernels some distance from the dividing lines, so that the slight displacement caused by handling the tester will not mix the samples. Fold each side of the tester over, so that the edges meet in the middle. Press the cloth down firmly over the kernels, and using a cob or some other cylindrical object as a core, roll the tester completely. Tie a cord or slip a rubber band around the middle, and the doll is complete. Thoroughly immerse the dolls in lukewarm water. From two to four hours have been found sufficient for soaking, and it is best not to soak them for more than 10 hours. Remove the dolls from the water, allow them to drain, and place them where they may be kept warm and moist. During the germination period keep dolls at a temperature between 80° and 90° F. during the day and 50° and 60° during the night. It is not advisable to give the dolls a second soaking. Wrap them in a piece of wet sacking, or put them upright in an ordinary bucket and cover with a wet cloth. In either case make provision for draining off excess moisture. At the end of five days the kernels should be sprouted sufficiently to show their fitness for seed. Sprouted stalks or plants should indicate vigorous development and freedom from disease.

Modified Rag-Doll Germinator.—The rag-doll germinator has been modified so that diseased kernels can be detected by it. It consists of a muslin cloth 12 inches wide by 54 inches long, which has been boiled in water for at least 15 or 20 minutes, thoroughly rinsed and placed on a strip of firm, water-finish fiber paper of equal width and slightly longer. Place the kernels from each ear in a row with the germ sides down and with tips all pointing toward what will be the lower end of the doll when it is placed in the germinator box. Wet the cloth thoroughly and then carefully roll up the paper, cloth, and kernels. Place rubber bands around each end of the doll. Indicate the upper end of the doll by attaching a tag bearing the numbers of the ears used and the date of the test. Place the rag-doll germinators in a box receptacle, which consists of an inner and outer box, with sawdust between them. The inside box may be of any convenient size, but should be at least 18 inches deep. Wire cross rods should be spaced at least 3 inches

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apart in the upper part of the inner box. The sawdust layer should be at least 2 inches thick between the boxes. When the box is in use the sawdust is kept thoroughly wet and the rag dolls are sprinkled twice daily. Keep the top of the germinator box covered with wet gunny sacks. Keep the box at a temperature of 75° to 85° F. Where electric current is available heating has been accomplished satisfactorily by use of electric bulbs under the boxes.

At the end of seven days the dolls are ready for readings. Remove from the germinator and unroll. The seedlings that are rotted indicate the ears that are to be discarded. Some seedlings which appear healthy grow from kernels rotted on the inside. The only safe practice is to cut open lengthwise all kernels not evidently rotted. Ears represented by seedlings with weak and slender sprouts or short and slender feeder roots are undesirable for seed and should be thrown out along with those ears represented by rotted seedlings. The best seed ears of a well-bred strain of corn will produce thick, sturdy sprouts, an abundance of thick, healthy roots, and show no evidence of rotting when cut open. The kernels from the best fully matured ears usually remain free from molds, even when the corn has remained in the germinator longer than seven or eight days at a temperature of 85° to 88° F. Those ears should be selected for seed which are represented in the germinator by kernels that all germinate and all show clean, vigorous seedlings, without rotting.

Grading Seed Corn.—Shelled corn is difficult to grade satisfactorily. The grading can be done better before the ears are shelled. If the seed ears differ greatly in size of kernels, separate into two grades. The grades should be shelled separately, tried in the corn planter, and numbered to correspond with the number on the planter plates found to drop them most uniformly. These arrangements can be completed before the rush of the spring work begins.

Methods of Shelling.—Remove the small kernels from the tips of the ears and the round, thick kernels from the butts. The small tip kernels are more likely to be damaged than the other kernels of the ear. The round butt kernels are as productive as the other kernels of the ear, but do not drop uniformly in the planter. Shelling carefully by hand is profitable. Shell each ear separately into a large sieve (quarter-inch mesh and concave bottom), rejecting any worm-eaten or blemished kernels. If the supply from the one ear appears good and contains no poor kernels, it should be poured into the general supply and another ear shelled in the same way.

Determining the Yield on Competitive Plats.—A plat consisting of four corn rows 4,400 feet long and 3.3 feet apart occupies 1 acre if measured from one outside row to the other, but by correct measurement it occupies 1⅓ acres of land. The number of rows must be multiplied by the average width between rows and this product multiplied by the full length of the plat to obtain the true area from which the corn received benefit. To make the records of value and have them comparable from year to year it is necessary to determine the moisture in the harvested corn. To accomplish this, 100 pounds of ears should be weighed when harvested, put in an airy place till as dry as old corn and then weighed again and shelled. The weight of shelled corn is the percentage of dry

shelled corn, and multiplying the total pounds harvested by this percentage gives the yield in pounds of dry shelled corn. If the plot was harvested directly after the seed was selected, the harvest weights of all can be reduced to pounds of dry shelled grain by the one calculation. But if the seed was selected while in a sappier condition, a similar process is necessary to determine the pounds of dry shelled grain taken from the acre for seed. Old corn, or corn containing approximately 12 per cent of moisture, is considered dry corn. Fifty-six pounds of shelled corn constitute a bushel.

Shelled-Corn Standards.—(See 2.041.)

White corn.—This class shall consist of corn of which at least 98 per cent by weight of the kernels are white. A slight tinge of light straw color or of pink on kernels of corn otherwise white shall not affect their classification as white corn.

Yellow corn.—This class shall consist of corn of which at least 95 per cent by weight of the kernels are yellow. A slight tinge of red on kernels of corn otherwise yellow shall not affect their classification as yellow corn.

Mixed corn.—This class shall consist of corn of various colors not coming within the limits for color as provided in the definitions of white corn and yellow corn. White-capped yellow kernels shall be classified as mixed corn.

Grades.—The Federal grades for corn are based on factors of condition and quality. The best corn is graded No. 1, with not more than 14 per cent moisture, and corn decreasingly inferior is given numerical grades down to and including No. 6, with not more than 23 per cent moisture. Sample grade is corn too poor to meet the requirements of the numerical grades.

Grain Sorghums (See .47)

Comprise several groups, each having a different name and each containing several varieties. The groups are closely related botanically, and are similar in general appearance and in culture and use. The principal groups are kafir, milo, feterita, and durra. In comparison with most of the principal cereal crops, the grain sorghums are not very important. However, these crops are of much importance in the southern section of the Great Plains area comprising portions of Kansas, Oklahoma, Texas, and New Mexico. In this section they take the place occupied by corn in the more humid parts of the country. They are the tilled-grain crop in the rotation, and they provide the feed grain and roughage for farm and range livestock and silage for the dairy and beef industries. The average yield of grain varies from about 12 bushels in poor seasons to more than twice that quantity in favorable seasons. The milos and feterita ripen in 90 to 110 days, which adapts them to short seasons, higher elevations, and low rainfall. The kafirs are not so early and require more moisture. They do best where the rainfall is about 25 inches and the elevation ranges up to about 2,000 or 2,500 feet. Pure seed is important. Select the seed heads from the standing stalks before the crop is harvested, so the best plants may be found. These crops will grow on most kinds of soil. It pays to delay sowing until the soil is warm. Cold soil injures germination and delays growth. From 2 to 3 pounds of good, clean seed are required to sow an acre. On the average 18 to 24 inches of row space

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to the plant in rows 3½ feet apart is best for the milos and feterita, and 12 to 14 inches for the kafirs. Clean cultivation is essential. Kill the weeds, and keep the surface soil loose. After harvesting, dry or cure the heads properly before threshing and adjust the thresher so that the grain will not be cracked. The grain should be clean and dry before it is stored in bulk. Watch for signs of heating.

Standards.—(See also 2.041.) Grain sorghums shall be any grain which consists of kafir, milo, durra, feterita, darso, freed sorgo, kaoliang, schrock kafir, and shallu, and any hybrids between these classes, and not more than 35 per cent of nongrain sorghums, other cereal grains, and "foreign material and cracked kernels," as defined in the standards.

Grade.—Grade depends upon quality at time of inspection. Each class or subclass is divided into four grades, Nos. 1, 2, 3, and 4, with a "sample grade" for grain failing to meet the specification of any of the numbered grades.

Oats

General.—Of the major cereal crops of the United States the oat crop ranks third in importance. In acreage and value it is exceeded only by corn and wheat. During the decade from 1910 to 1919, inclusive, the annual production of oats reached 1,500,000,000 bushels. The important and almost unique place this crop occupies, regardless of the fact that its cash value alone seldom offers much inducement for production, is due to (1) its unsurpassed feeding value for horses and young stock, (2) the difficulty of replacing it by any other crop in our general farming system, and (3) the economy of labor in growing and handling the crop.

Climatic Factors.—Oats attain their best growth in regions of cool, moist climate, such as are found in many of the northern European countries, in the northern United States, and in Canada. The following 10 States lead in the production of oats: Iowa, Illinois, Minnesota, Wisconsin, South Dakota, Nebraska, Indiana, North Dakota, Ohio, and Michigan.

Soils.—Because of their greater water-holding capacity, fairly fertile clay and loam soils are most satisfactory for oats. Good oats may be grown on sandy soils that contain plenty of plant food and overlie a subsoil that is fairly retentive of water. On very rich soils oats frequently lodge badly because of excessive growth of straw.

Fertilizers.—On the average soil under the average general farming rotation practice, an application of 150 to 200 pounds of acid phosphate is the most common fertilizer for oats. Complete fertilizers containing an excess of nitrogen may cause serious lodging. Best results usually are obtained by the application of stable manure to the previous row crops, such as corn or potatoes.

Rotations.—

Principal rotations in which oats occupy an important place

Section	Rotations
Northeastern and upper Mississippi Valley States	Corn (2 years), oats (3d year), and grass or clover (2 or more years); corn (1 t year), oats (2d year), and grass and clover (2 years); corn (1st year), oats (2d year), winter wheat (3d year), and grass or clover (1 or more years); potatoes (1st year), oats (2d year), and clover (3d year).
Southern States	Cotton (1st year), corn (2d year) with cowpeas or soy beans or crimson clover planted at last cultivation, fall-sown oats followed by soy beans or cowpeas (3d year); corn (1st year) with cowpeas or soy beans in the rows, oats (2d year) with clover or grass sown with the oats, and grass or meadow (3d year). (In last rotation potatoes or other cultivated crop may be substituted for corn.)
Irrigated areas of the West.	Oats (1st year), clover or alfalfa (a number of years), sugar beets or potatoes (2 or 3 years), oats (1 year), wheat (1 or 2 years), alfalfa (3 or more years); sugar beets, corn, or potatoes (2 years), oats (3d year), and clover (2 years).

Mixtures With Other Crops.—Oats and Canada field peas form the most common combination of the kind in the United States, especially in the northern section. This mixture is used as pasture or is cut for feeding green or for hay. Usually the rate of seeding is 4 pecks of peas and 6 pecks of oats per acre. Rape may be sown with oats to be used as pasture for hogs and sheep after the oats are harvested.

Use as a Nurse Crop.—Oats are not considered so satisfactory a nurse crop as either barley or wheat. These cereals produce less shade and require less water. Early varieties, therefore, are preferable, as they grow less rank and remove a smaller quantity of water from the soil. In addition they usually mature sufficiently early to harvest before the advent of hot weather, which is likely to injure the young grass.

Use as a Cover Crop.—Sow field peas with oats, particularly when used in orchards in the North. Vetch may be substituted where adapted. In the South, fall-sown oats, grown for either grain or hay, make an excellent cover crop.

Seed Bed.—Where oats follow corn, as they do in much of the Corn Belt, plowing is not necessary. As a rule, a more satisfactory seed bed can be prepared by disking and harrowing. At least one disking should precede sowing the seed when it is to be broadcast. The best seed bed is one that is firm and has 2 or 3 inches of loose, mellow soil on the surface. Soils that are not likely to blow or puddle frequently can be plowed in the fall to good advantage, particularly if grass seed is to be sown with the oats, when a fine, smooth, mellow seed bed is desirable.

Seeding.—Most experiments in methods of seeding, that is, drilling versus broadcasting, have resulted in a slightly higher yield being obtained from drilling. Drilling east and west probably is preferable to drilling north

and south. Disk drills are a little more satisfactory than shoe and hoe drills, particularly when the soil contains weed stems, cornstalks, or other crop residue. In stony soils hoe drills are preferable. Best results are obtained by seeding from 1 to 2 inches deep. Oats may be sown as deep as 4 inches without materially affecting the yield. In the northern half of the United States sow between March 10 and May 10. In the Southeastern States fall seeding is done between September 20 and December 1 and spring seeding between February 1 and April 15; in California, November 1 to March 1; and in the Pacific coast section of Oregon and Washington, from October 1 to November 15 and March 15 to April 15. The rate of seeding for the humid sections is 8 to 12 pecks per acre; for the dry-land (Great Plains) area, 4 to 6 pecks; and for the irrigated sections, 6 to 10 pecks.

Harvesting.—Cut oats when they are in the dough stage If they are allowed to become fully ripe, some loss may occur by shattering. Oats usually are cut with a grain binder, though in the drier sections the header or the combined harvester and thresher is used occasionally.

Proportion of Grain to Straw.—This varies widely according to the variety, the season, climate, and soil conditions. Usually the proportion varies from 1⅓ to 1½ pounds of straw to 1 pound of grain. In early, short, fine-strawed sorts, such as Kherson (Sixty-Day) and selections from it, the proportion is about equal. Under irrigation with an abundant water supply the proportion is higher, probably averaging 2 pounds of straw to 1 pound of grain.

Proportion of "Meat" to Hull.—This also is decidedly variable. It may vary from 55 to 80 per cent, the average being from 70 to 75 per cent. In late thick-hulled varieties, such as Tartar King and Storm King, the percentage of meat is low. The proportion is highest in the early, small-kerneled, thin-hulled varieties, of which the Kherson is most typical.

Utilization.—About 3 per cent of the oat crop is milled for human consumption. Usually about one-third of the total crop is sold by farmers. Farm consumption absorbs the remainder of the crop.

Varietal adaptation of oats

State or group of States	Time of maturity		
	Early variety	Midseason variety	Late variety
New England	----------	Lincoln, Maine 340, Swedish Select, and Victory.	White Tartar.
New York	----------	Cornellian, Comewell, Empire, Silvermine, Standwell, Swedish Select, and Victory.	
Pennsylvania, Maryland, West Virginia.	Kherson (Sixty-Day), Gopher, and Iowar.	Keystone, Patterson, Silvermine, Swedish, Select, and Victory.	White Tartar

Varietal adaptation of oats—Continued

State or group of States	Time of maturity		
	Early variety	Midseason variety	Late variety
Virginia, Tennessee, Kentucky.	Fulghum, Kherson, and Burt; for fall seeding, Winter Turf and Culberson.	----------------	
North Carolina, South Carolina, Florida, Georgia, Alabama, Mississippi, Louisiana.	Red Rustproof (Appler, Bancroft, Hasting Hundred Bushel, Ferguson No. 71, Texas Red), and Fulghum; for spring seeding, Burt and Fulghum.	----------------	
Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, North Dakota, South Dakota, Nebraska, Montana, Wyoming.	Ohio 6222, Kherson, Iowar, Albion, Richland, States Pride, Gopher, Nebraska No. 21, Fulghum, and Burt.	Silvermine, Minota, College Success, Worthy, Wisconsin Wonder, Swedish Select, Victory, Lincoln, Markton, Iogren, Green Russian.	White Tartar.
Missouri, Kansas, Arkansas, Colorado, Oklahoma.	Fulghum, Kanota, Red Rustproof, Burt, Kherson, Albion, Iowar.	----------------	
Oregon, Washington.	----------------	Markton, Lincoln, Victory, Silvermine, Swedish Select, Banner.	Oregon Gray, White Tartar.
California-------	Red Rustproof (California Red), Fulghum, Kanota.	Abundance-----	
Irrigated districts in New Mexico, Utah, Arizona, Colorado, Nevada, Idaho, Montana.	----------------	Silvermine, Colorado No. 37, Swedish Select, Idamine, Victory, Lincoln.	White Tartar.

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Standards.—(See also 2.041.) For the purpose of official grain standards of the United States:

Oats.—Oats shall be any grain which consists of 80 per cent or more of cultivated oats and not more than 10 per cent of foreign material.

Color classification.—All oats shall be designated as white, red, gray, black, or mixed, according to the color of the oats, as the case may be. For the purpose of this classification, white oats include yellow oats. Oats shall be white, red, gray, or black, respectively, when they consist of oats of such color, and not more than 10 per cent of the other colors of cultivated and wild oats, either singly or in any combination. Mixed oats shall be all other oats.

Grades.—All classes of oats are divided into four numerical grades (1, 2, 3, and 4), dependent upon the following factors: Condition and general appearance, test weight per bushel, sound oats, heat damage, foreign material, wild oats, and mixtures of other classes of oats. Oats failing to meet the specifications for any one of the four numerical grades are called "sample grade."

Seed Flax (See .34)

Among the grain crops of the United States seed flax ranks seventh in acreage and eighth in value. It is grown in the same region as the hard spring wheats. The four States of North Dakota, Minnesota, South Dakota, and Montana produce 95 per cent of the total crop. In these States flax is important as a cash crop and also for sowing late in the spring on newly broken sod or on land previously too wet to work. Sow flax on clean land. If grown in rotation with other crops it should follow corn or some other cultivated crop rather than any of the small grains. It does best on loam or clay soils which are fertile and retentive of moisture.

Sow with a grain drill on a firm seed bed that has a fine surface. To insure satisfactory germination sow about 1 inch deep. Sow early, as soon in the spring as the land is prepared and before the surface becomes dry. For seeding in the humid region of Minnesota, Iowa, and Wisconsin, from 20 to 24 quarts (35 to 42 pounds) per acre is recommended. In the eastern half of the Dakotas 16 to 20 quarts (28 to 35 pounds) per acre is the usual rate, and in the drier region west of the one hundredth meridian (central Dakotas) 12 quarts (21 pounds) is sufficient. On old land wilt-resistant varieties can be recommended. These include Linota (N. D. No. 40,015), North Dakota Resistant No. 114, Winona, and Chippewa. On new land the larger-seeded nonwilt-resistant flaxes, Reserve (N. D. No. 155), Stark (C. I. No. 185), and North Dakota Resistant No. 52, are satisfactory.

On the small farm harvest flax with a grain binder. When bound and shocked, the grain is kept from the damp earth so that it will dry more readily after rains. Often the binding attachment is removed, a buncher attached, and the flax dumped in loose bunches on the ground. Sometimes the header can be used to better advantage than the binder for harvesting large acreages. Either the flax is then stacked, or a buncher attachment is used and the flax dropped in large bunches. Because the separator must be specially adjusted for flax, threshermen usually prefer to thresh all other grain before beginning the flax crop. Where flaxseed is stored for seed it should first be cleaned. Only the plump, sound, dry seed should be saved. This will reduce the danger of heating and also the development of disease from the

chaff and immature seed, upon which the disease spores are readily carried.

Mixed Flax and Wheat Cropping.—Mix the two grains at the granary in equal proportions and sow at the rate of 50 to 80 pounds per acre, depending upon the rainfall, sowing at the heavier rate in Minnesota and at the lighter rate in central North Dakota. Early and shallow seeding (1 to 2 inches) are recommended.

Standards.—(See also 2.041.)

Classes.—Three commercial classes of flaxseed are recognized: (1) Northwestern-grown seed—North Dakota, South Dakota, Minnesota, Montana, and a small portion of northern Iowa; (2) southwestern-grown seed—Missouri, Kansas, Nebraska, and eastern Wyoming; and (3) foreign seed—South America, Manchuria, and India.

Grades.—Six States and four boards of trade or chambers of commerce have special sets of grading rules for grading flaxseed. The grades vary in number from three to four, usually one or two grades being important. Federal grades have not yet been promulgated. Since about 75 per cent of our domestic crop is marketed at Minneapolis and the remainder at Duluth, Milwaukee, and Chicago, the rules of the Minnesota State Inspection Department are most largely in use. The Minnesota grades, effective September 1, 1922, are as follows: No. 1 flaxseed—shall be sound, dry, and free from mustiness, shall be northern-grown, shall weigh not less than 49 pounds to the measured bushel, and shall contain not more than 20 per cent of damaged seed; No. 2 flaxseed—shall be sound and dry, shall weigh not less than 47 pounds to the measured bushel, and shall contain not more than 30 per cent of damaged seed; Sample grade—shall be flaxseed which does not come within the requirements of the above grades, or that is damp, warm, moldy, fire-burnt, very musty, or otherwise unfit for storage. Flaxseed shall be tested after it has been cleaned and the amount of foul seed or dockage determined.

Rice

In southwestern Louisiana and southeastern Texas, rice is almost the only source of income. In some of the parishes and counties of this district more than 75 per cent of the cultivated land is used for rice growing. There is a similar, though smaller, prairie district in eastern Arkansas, approximately 50 miles wide and 150 miles long. In California it is confined mostly to the heavy clay and clay-adobe soils of the middle Sacramento Valley, where abundant water is available for irrigation.

The principal physical factors affecting rice production are irrigation water, precipitation, temperature, and soil, and of these irrigation water is the most important. A depth of approximately 6 inches of water must be maintained throughout a period of at least 75 days. Fields should be leveled and the checks laid out carefully, so that water can be applied to them easily and uniformly. The crop requires a relatively high humidity and a mean temperature above 70° F. during the growing season of four to six months.

Rice is most productive on soils that are medium to rather heavy in texture. Land to be sown is either winter or spring plowed and is then disked and harrowed, or the clods crushed with drags. Seed is either drilled or broadcast. Early shallow seeding at the rate of 65 to 80 pounds per acre is used for prairie rice culture, whereas 115 to 130 pounds on new land and 125 to 145 pounds

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on old land usually gives the best results in the Sacramento Valley. In the South sow between April 1 and May 15, and in California April 15 to June 1. The leading varieties in the South are Blue Rose, Early Prolific, Honduras, and Fortuna; and in California, the Wataribune, Colusa, and Caloro. Rice is harvested with a twine binder, but in some regions it is cut with a hand hook, particularly on the Mississippi River plantations in Louisiana. Shock promptly to protect it from sun and rain. Thresh about two weeks after cutting, when the kernel is hard and the straw is thoroughly dry.

Rye

Rye can be grown in practically all parts of the United States, but is most profitable in the Northern and Eastern States. Winter rye is the hardiest and earliest of all cereals and successfully survives the winters in the cold northern section of North Dakota and Montana. It is grown largely as a cash grain crop, but is used also as a green-manure or nurse crop, and to smother weeds. The growing of winter rye in the spring-wheat area permits a better distribution of labor, because it can be sown in grain stubble in the fall and is harvested before other grains are ripe. Can be grown on grain stubble, corn ground, fall-plowed land, or summer-fallow. Sowing on grain stubble often is the most profitable because of the cheaper cost of production. Winter rye should be sown about August 15 to September 1 in the northern part of North Dakota and Minnesota, but later dates of sowing usually give better results south of this section. Spring rye should be sown as early as feasible. Sow with a grain drill at the rate of 4 to 6 pecks per acre. It is usually harvested and threshed like other small grains. The Rosen variety is best adapted to Michigan and the Corn Belt region, but is less productive than other varieties in the cold, northern sections, in semiarid lands, and in the South. Dakold (N. Dak. No. 959), a very hardy winter variety, is the most productive rye in North Dakota and northern Montana. Swedish (Minn. No. 2) has given the highest yields in Minnesota, and Advance in the eastern half of South Dakota. Two selections from the Schlanstedt variety, Wisconsin, and Pedigree Nos. 2 and 12.19, have yielded best in Wisconsin. In a large part of the Cotton Belt the Abruzzes variety gives good results. Much of the rye crop in the United States is shipped abroad, and the remainder is mostly ground into flour.

Standards.—(See also 2.041.)

Rye.—Rye shall be any grain which, before removal of dockage, consists of 50 per cent or more of rye, and when free from dockage contains not more than 10 per cent of cereal grain of a kind or kinds other than rye.

Grades.—All rye shall be graded and designated No. 1, No. 2, No. 3, No. 4, or sample grade, as the case may be, according to the respective requirements. Sample-grade rye shall be all rye which does not come within any of the grades from Nos. 1 to 4, inclusive, or which has any commercially objectionable foreign odor except of smut, garlic or wild onions, or is very sour, or is heating, hot, or otherwise of distinctly low quality, or contains small, inseparable stones or cinders.

Wheat

General.—One of the most important crops of the United States because (1) many farmers grow it, (2) a large acreage of land is annually devoted to it, (3) it consti-

tutes an important part of our domestic commerce, (4) it contributes a large part of the value of the exports of the Nation, and (5) it is the national bread crop. In some areas it is practically the only source of income. About one-third, or 2,000,000, of the farmers grow wheat in this country, and in many of the Northern States more than half, and in large areas more than four-fifths of the farmers are growing it. Only corn and hay exceed wheat in the acreage occupied.

Climatic Factors.—Too much or too little moisture, and the occurrence of frost and freezing temperatures, hail, hot winds, and storms take their toll from the wheat crop. Some of the winter-wheat acreage sown in the fall always is abandoned the next spring. The best wheat-producing regions are in the Middle West and North. The more humid climates produce the soft wheats and drier climates the hard wheats.

Soil.—Wheat grows best on virgin soil or on land that has been renewed by means of clover, manure, or some other form of fertilizer. Commercial fertilizers are effective on soils of less than average fertility. On such land from 250 to 300 pounds of a complete fertilizer, such as a 4–12–4, may be used.

Seed Bed.—Prepare a firm, well-worked seed bed carrying sufficient moisture for rapid germination. If winter wheat follows oats or barley, plow the stubble ground as soon after harvest as possible. Disking as soon as oats and barley are harvested will prevent the loss of much moisture, and a better job of plowing can be done. Plow for wheat at an ordinary depth (optimum depth, 4 to 8 inches). Deep plowing is advantageous for wheat grown continuously, but not for wheat grown in rotation. Early plowing compared with late plowing in either fall or spring favors nitrification. Plowed land does not hold snow so well as stubble land and may or may not absorb rainfall more readily. Fall plowing may or may not control weeds better than spring plowing, although fall plowing usually is rather effective in destroying many soil and stubble infesting insects. In many sections spring plowing results in as high or higher yields than fall plowing of spring grains sown at the same time for both preparations. The chief advantages of fall plowing for spring grains are the better distribution of labor and making earlier spring seeding possible. In regions where winter wheat follows corn, beans, or other cultivated crops a thorough disking as soon as the crop is harvested will prepare a satisfactory seed bed. Spring wheat does best on fall-plowed land or land plowed and fitted as early as possible in the spring. Tillage of summer-fallowed land increases nitrification and destroys weeds. An ideal seed bed for wheat is a rather loose and pulverized layer about 3 or 4 inches deep with fairly compact soil below.

Seeding.—Cleaning seed by means of a fanning mill removes trash, dirt, light kernels, and weed seeds, facilitates seeding, and prevents the sowing of noxious weeds. Screening or fanning out the small or light seeds from clean grain has only a slight effect upon yield when the seed is sown at the optimum rate per acre. For spring wheat sow as early as land can be put into condition. For winter wheat in the Eastern States sow after fly-free date as recommended by each State. For winter wheat in the Western States sow as follows: Montana—August 15 to October 1; South Dakota, Wyoming, Colorado, and Utah—September 1 to October 15; Oregon, Washington, and Idaho—September 1 to November 1, if moisture is sufficient to bring up the wheat; California and southern Arizona—November 1 to February 1. The

foregoing includes the extremes of successful sowing dates. The optimum date usually lies at about the midpoint between these extremes. Sow with a grain drill, seeding from 1½ to 3 inches deep, the deeper sowing in light, loose, or dry soil, the rows 6 to 8 inches apart. Depths of seeding between 1 and 4 inches result in nearly the same yield. For semiarid sections seed at the rate of 4 pecks per acre, for subhumid sections 5 pecks, and for humid and irrigated sections 6 pecks. Same rate for both winter and spring wheat. Rates higher than these are recommended for poor seed, formaldehyde-treated seed, uneven seed bed, and late sowing.

Harvesting.—Cut with the binder when the stiff-dough to hard-dough stage is reached. At this time the kernel may be dented easily by the finger nail but resists crushing with the finger. Earlier cutting will reduce the yields and shrivel the grain. Later cutting may result in losses from shattering. Early cutting of rusted wheat is of no advantage and usually decreases the yields. When the header is used cut when the green color is gone from the straw. When the combined harvester is used cut when the grain is hard and dry. When thresher service is certain wheat may be threshed from the field, but under humid conditions the wheat growers may be well repaid for the labor of stacking or placing it in hay sheds or barns.

Cleaning and Grading Market Grain.—Separate screenings on the farm and feed to livestock. The average wheat screenings are nearly equal to oats in feeding value. Recent figures show that the average dockage in threshed wheat is: North Dakota, 11.3 per cent; South Dakota, 7.7 per cent; Minnesota, 7.2 per cent; and Montana, 2.5 per cent. Screenings can be cleaned out of wheat at the time of threshing or at farm granaries at a cost of 2 or 3 cents per bushel. Spring-wheat farmers who cleaned their market wheat gained more than 5 cents per bushel as a result of cleaning. Cleaning will often raise the grain one or more grades.

Change of Seed.—No advantage in changing seed of reasonably plump wheat unless a better variety is obtained or the new seed contains fewer weed seeds and seed-borne diseases.

Standards.—(See also 2.041.)

Classes.—Under the official wheat standards of the United States, wheat is separated into five commercial classes: (1) Hard red spring, (2) durum, (3) hard red winter, (4) soft red winter, and (5) white. The soft red winter class includes the club wheats having red kernels, and the white wheat class the white-kerneled club wheats. The wheats included in each market class are somewhat similar in agronomic characters and adaptation. If wheat of one class has more than 10 per cent of another mixed with it, the mixture is classed "mixed wheat." These classes are divided into subclasses on the basis of color and texture of kernels. Subclasses are recognized because, so far as these classes are concerned, the best outward index of quality, from the standpoint of utilization of flour made therefrom, is the color and texture of kernels, namely, whether dark, hard, and vitreous, or yellow, mottled, and starchy.

Hard red spring.—Grown principally in the north-central part of the United States, where the winters are too severe for the production of winter wheat. Nearly 14,000,000 acres of this class of wheat are grown annually in this country, constituting nearly one-fourth of the total wheat acreage. Although there are 25 varieties of this class, about two-thirds of the acreage is sown to one variety, Marquis. The other varieties are Kota,

Power, Ruby, Prelude, Red Fife, Glyndon, Wellman, Ghirka, Kitchener, Red Bobs, Kinney, Huston, Haynes Bluestem, Dakota, Java, Dixon, Preston (Velvet Chaff). Converse, Champlain, Fretes, Chul, Progress, Ladoga, and Humpback. These varieties are distinguished by having hard, red kernels. The strongest flours for bread making are produced from this class.

Durum.—Grown in almost the same area as hard red spring wheat. The district of heaviest production of durum wheat is just west of the Red River Valley in North Dakota. About 4,000,000 acres have been grown annually in this country for several years. It constitutes about one-sixteenth of the total wheat acreage. Arnautka and Kubanka are the leading varieties among the 13 commercial durum wheats grown. The other varieties are Nodak, Kubanka No. 8, Mindum, Buford, Acme, Monad, Marouani, Pentad (D–5), Peliss, Velvet Don, and Kahla. All the durum wheats are spring varieties with long stiff beards, and most of them have short, thick, and compact heads. The heads are flattened across the sides rather than along the faces of the meshes, as with common wheat. These varieties are distinguished by having very hard white (amber) kernels, except Pentad, which has red kernels. Used chiefly for the manufacture of granular flour called semolina, from which macaroni, spaghetti, and other alimentary pastes are made. Durum wheat usually yields more than hard red spring wheat in this northern spring-wheat belt, because of its greater resistance to drought and to black stem-rust.

Hard red winter.—Grown principally in the central Great Plains area, where dry summers and rather dry winters prevail. Not well adapted to humid sections. More than 17,000,000 acres are grown annually in this country, constituting nearly one-third of the total wheat acreage. Only a few distinct varieties are grown, the original strains having been introduced from Russia. They have become important in the United States because of their winter hardiness, drought resistance, and high yields. The varieties are Turkey, Kharkof, Iowa No. 404, Ilred, Nebraska No. 60, Nebraska No. 6, Wisconsin Pedigree No. 2, Montana No. 36, Kanred, Bacska, Blackhull, Minturki, Karmont, Sherman, Iobred, Michikoff, Ridit, and Mosida. These varieties are distinguished by having hard red kernels and are grown from fall sowing. Used in the manufacture of a flour of high breadmaking quality.

Soft red winter.—Grown largely in the humid sections in the eastern half of the United States. About 16,000,000 acres are grown annually, composing more than 30 per cent of the total acreage. Two varieties of club wheat having red kernels, but which are grown mostly from spring sowing in Washington and Idaho, are classed as soft red winter wheat in the official grain standards of the United States, but are listed separately here. The leading eastern-grown varieties are Fultz, Trumbull, Ashland, Zimmerman, Walker, Rice, Oakley, Wyandotte, Flint, Purplestraw, Climax, Leap, Prosperity, Forward, Harvest Queen, Fultzo-Mediterranean, Fulhio, Poole, Portage, Russian Red, Red May, Illini Chief, Red Clawson, Rochester, China, Wheedling, Currell, Red Wave, Homer, Rupert, Resaca, Gold Drop, Rural New Yorker No. 6, Shepherd, Ohio 9920, Jones Fife, Mealy, Grandprize, Fulcaster, Nigger, Pennsylvania 44, Mammoth Red, Gipsy, Gladden, Valley, Sibley, Rudy, Silversheaf, Golden Cross, Mediterranean, Goens, Red Rock, Diehl-Mediterranean, Pride of Genesee, and Penquite.

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The leading western-grown varieties are Big Frame, Lofthouse, Buffum No. 17, Minhardi, Red Russian, Sol, Squarehead, Fleming, Peterson, Odessa (eastern also), Squareheads Master, Triplet, Nebraska 28, and Cox. These varieties are distinguished by having soft to semihard kernels and are grown almost exclusively for fall sowing. Soft red winter wheat is used in the manufacture of both bread-making and pastry flours. The flour from hard red winter and hard red spring wheats often is blended with that of this class to make it a stronger bread flour.

White.—Grown in the eastern and western parts of the United States. Where now grown it usually outyields the other classes of wheat. More than 3,000,000 acres, or about 5.4 per cent of the total wheat acreage, are devoted annually to the production of common wheat, of which 54 varieties are commercially grown. The white wheat class includes the white-kerneled varieties of both common and club wheats, but the club wheats are listed separately here. The winter varieties are White Winter, Eaton, Martin, Prohibition, Greeson, White Wonder, Winter Bluestem, Goldcoin, Dawson, Honor, Arcadian, Kofod, Windsor, Silvercoin, Democrat, Genesee Giant, and Read. The spring varieties are Pacific Bluestem, Mexican Bluestem, Bunyip, Dart, White Federation, Bobs, Defiance, Regenerated Defiance, Early Defiance, Colorado No. 50, Lynn, Touse, New Zealand, Gypsum, Surprise, Dicklow, Quality, White Fife, Rink, Pilcraw, Onas, Federation, Hard Federation, John Brown, Allen, Foisy, Indian, Jumbuck, Sonora, Galgalos, Baart, Propo, Palisade, Talimka, Sevier, and Canadian Red. The kernels of these spring and winter wheat varieties are described as white because they lack the coloring matter or pigment in the seed coat, or bran, which red wheats possess. The kernels are not really white but rather a pale yellow, although they may be hard and translucent (amber) or soft and opaque. This class of wheat is used in making pastry flours, breakfast food, and to some extent in bread-making flours.

In some sections west of the Rocky Mountains club wheats outyield all other varieties. Although more than 1,000,000 acres are grown annually club wheat constitutes less than 2 per cent of the total wheat acreage. There are 14 distinct varieties grown commercially, namely: Little Club, Big Club, Hybrid 128, Hybrid 143, Hybrid 63, Hybrid 123, Hybrid 108, Jenkin, Redchaff, Bluechaff, Dale, Coppei, Wilbur, and Mayview. The club wheats have short, thick, and very compact heads, and small kernels. The kernels are either red or white, and this class of wheat is grown for both spring and fall sowing. The grain of most of the varieties is soft and inferior to other classes of American wheats for milling and bread making. Under the official grain standards of the United States the white-kerneled varieties are graded in the subclass (*c*) Western White of the Class V white wheat, and the red-kerneled varieties in the subclass (*b*) Western Red of the Class IV soft red winter wheat. White club wheat is used in making starchy flours for pastry or is exported to South America and the Orient.

Grades.—Each subclass of wheat is divided into five numerical grades (1, 2, 3, 4, and 5), dependent upon the following factors: Test weight per bushel, moisture content, percentage of damaged kernels, purity, cleanliness, and condition. When failing to meet the specifications for any one of the five commercial grades it is graded "Sample Grade."

Miscellaneous

Adlay.—Coarse biennial or perennial grass sparingly grown as a food crop in certain parts of the Philippine Islands. Has been exploited as a grain plant for the Tropics. Has no economic promise in this country.

Einkorn.—Name is of German origin and means "one-grained." In French it is called "engrain." It is distinct from emmer and spelt in having narrow, slender spikes. The spikes are awned and laterally compressed, and the terminal floret usually is sterile. The kernels remain in the glumes when threshed. They are pale red in color, small, slender, and very much compressed laterally. The common einkorn contains but one kernel in each spikelet, but the double einkorn contains two kernels. The plants are late in maturing. On account of the stems being slender and short, harvesting with the grain binder is difficult. Einkorn has been grown in an experimental way in the Dakotas, Washington, and Canada, but is of no economic value in the United States.

Emmer.—Introduced into this country from Germany and Russia about 50 years ago. It is similar to wheat, but most of the kernels remain in the glumes after threshing. Emmer is of value in some of the semiarid regions of America. Both winter and spring varieties are known. All varieties of emmer grown commercially in the United States are bearded. Some varieties are resistant to rust. The States leading in the production of emmer are South Dakota, North Dakota, Nebraska, Minnesota, and Colorado. Spring emmer is best adapted to eastern North Dakota and South Dakota, but even there it usually yields less than the best varieties of barley and oats. Winter emmer is not an important crop in any part of the United States. The Vernal (white spring) or common emmer is the most productive spring variety, although Khapli appears promising in some sections. Black Winter emmer is not very winter-hardy or very resistant to rust or drought. Spring emmer yields best when sown early at the rate of 6 to 8 pecks per acre. As a feed for livestock the grain is somewhat bulky to use as the sole concentrate for fattening animals, and gives best results when mixed with corn or barley. Emmer can be distinguished easily from spelt by its compact spikes and by the short, narrow pedicel, which usually is attached to the base of the spikelets of the threshed grain. Not suitable for the manufacture of bread-making flours in this country.

Millets.—(See .43.)

Quinoa.—Annual of the pigweed family, the seed of which is used by the Indians of the Andean highlands of South America for flavoring and thickening soups. Introduced into the United States as a plant for the arid areas of the West. Has shown no promise where tried.

Spelt.—Grown in central and eastern Europe for human and animal food. In this country it is grown only on limited acreages, mostly in the eastern half of the United States. The grain resembles emmer in composition and feeding value. Both bearded and beardless and winter and spring varieties are known. The winter varieties usually will produce seed from spring sowing unless sown very late. Most varieties are rather tall. Spelt is not resistant to the different kinds of rust, but is more productive than barley and oats in Maryland and Virginia. Winter spelt should be sown at the rate of 8 to 12 pecks per acre at the time winter wheat is sown. Not suitable

for the manufacture of bread-making flours in this country.

Teff.—Annual grass of Abyssinian origin. Introduced into this country and tried in California where it has made a good growth. As a forage it can not compete with alfalfa. It apparently is without promise in the United States.

Wild Rice.—Principal use is food for wild ducks and other waterfowl. It is also used to a small extent as human food, particularly by some of the Indian tribes of the upper Mississippi Valley. Wild rice grows in shallow lakes and on marshy lands bordering tidal rivers above brackish water, where the streams are sluggish. Under these conditions, where it can anchor itself in a thick layer of mud, regardless of the kind of soil, the plant seems to make its best growth. Because it attracts ducks and other game birds, wild rice is often sown on hunting preserves, but the results frequently are unsatisfactory because the seed does not germinate well. To insure good germination keep the seed moist from the time it is harvested until it is sown, and store it at a low temperature. The seed should be sown broadcast about the middle of April at the rate of a handful of well-matured seed to 2 square yards of water surface.

FIBER AND TEXTILE CROPS

Abacá

The name abacá is preferred to manila hemp because neither the plant nor the fiber bears any relation to true hemp. The best and highest-priced grades of binder twine and all the better grades of rope are made from the fiber obtained from the leaf stems of the abacá plant. Abacá is closely related to the banana. It grows only in the warm, moist areas in the Philippines and Java. Plants are set out about 8 feet apart and attain a height of 15 to 20 feet. The first stalks are cut about 18 months after the suckers have been set out. The leaves are trimmed off and the trunks left 8 to 12 feet long and 5 to 18 inches in diameter, composed of the leaf stems overlapping in concentric layers that extend nearly from base to summit. The fiber-bearing outer layer about one-eighth inch thick, of each successive leaf stem, is peeled off in strips 1 to 2 inches wide. The thin, flat ribbons, or "tuxies," thus prepared are drawn by hand under a blunt knife pressed by a spring against a wooden block. This process scrapes away the pulp, leaving clean, white abacá fiber. The fiber is dried in the sun and after being sorted is ready to be baled for market. Twelve different grades of abacá are quoted on the market, the difference resulting chiefly from the greater or less care taken in cleaning and preparing the fiber. Most of the "pure manila" binder twine is made of the Government grades G to J inclusive. The grades C to F go into rope.

Broomcorn

Grown only for the brush, which is used in the manufacture of brooms and brushes. Because of its scant foliage, dry pith, and weedy stalk, the plant has very little forage value. Oklahoma, Texas, Illinois, New Mexico, and Colorado are the leading broomcorn States. The acreage in the Eastern States has decreased in the last 20 years. Broomcorn can be grown in almost any State in this country, but makes its best growth in a warm, sunny climate. The varieties are divided into two groups, the Standard and the Dwarf. The Dwarf varieties are adapted to the high altitudes and dry climate of the southern Great Plains States, and the Standard varieties to the humid conditions in the Eastern and the Central Western States. The crop requires practically the same cultural treatment as other sorghums or corn. In the Lindsay district in Oklahoma sow about April 15, and in central Illinois about April 25, although good crops are sometimes grown if sowing is delayed until July 1. Normally from 80 to 90 days are required for the brush to mature. More time is required to mature a seed crop. When the rows are 3½ feet apart, sow seed at the rate of 2 or 3 pounds per acre. Harvest the brush when it has reached the stage where the natural green color extends from the top of the fiber to the base and center of the head. If a seed crop is desired, do not harvest until the seed is fully mature. The Standard is bent over or tabled and the brush cut off, and the Dwarf is jerked or pulled from the upright stalk. A broomcorn

thresher has been constructed especially for this crop. Cure the brush rapidly, but do not expose to strong sunlight. A shed 10 feet high, 16 feet wide, and 24 feet long will furnish ample space for green brush that will make about 3½ tons after being cured. This is equal to the average yield of about 12 acres in the central Illinois district. About 1 cubic foot of space is required for each 2 pounds of cured brush. Careful grading, baling, and storing will help to increase the market value.

Cotton

Commercial Importance.—Cotton is the greatest commercial crop of the United States, all the lint and most of the cottonseed being sold off the farm. It is second in total crop value only to corn, when the value of both the lint and seed of cotton is considered. Exports of raw cotton also usually exceed in value the exports of any other crop.

Where Grown.—The Cotton Belt of the United States extends from southeastern Virginia through North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Arkansas, Louisiana, Texas, and Oklahoma. In recent years commercial production has extended into southwestern Kentucky, southern Illinois, southeastern Missouri, western Texas, New Mexico, Arizona, and California.

Commercial Types.—In the United States the cotton crop is broadly grouped into four general commercial classes, viz:

Sea-island cotton.—A fine, strong fiber, from 1½ to 2 inches or more in length. That formerly grown on the islands and mainland along the coast of South Carolina, with a fiber 2 or more inches long was considered the most valuable of the world's cottons. About 90,000 bales of sea-island cotton of all grades were produced annually in South Carolina, Georgia, and Florida, prior to the advent of the boll weevil. Commercial production has declined rapidly and is now confined almost entirely to the British West Indies, Porto Rico, and Peru.

Egyptian cotton.—A fine, silky, strong fiber from 1$\frac{3}{16}$ to 1¾ inches in length. The bulk of the crop comes from Egypt, where the average annual production is approximately one million five hundred thousand 500-pound bales, of which from 100,000 to 300,000 bales are exported to the United States. Varieties grown in Egypt range from 1$\frac{3}{16}$ to 1½ inches in length. A special variety produced in the United States and known in the trade as Pima produces a fiber 1½ to 1¾ inches long. Production of Egyptian cotton in the United States is confined to the Salt River Valley in Arizona, although it has been grown commercially in other irrigated valleys of both Arizona and California.

Upland long-staple cotton.—Including staples from 1⅛ to 1¾ inches in length. It is produced almost entirely in the United States, principally in the Delta of the Mississippi, and in the Red River, Pecos River, and Rio Grande valleys of Texas and New Mexico, and in parts of Arkansas, Arizona, California, and South Carolina. It occupies a commercial position between the longer-staple Egyptian and upland short staple. The annual production is about 1,500,000 bales.

Upland short-staple cotton.—Constitutes about 90 per cent of the cotton crop of the United States, and about 70 per cent of the world's crop of short-staple cotton of approximately 20,000,000 bales. Many varieties are grown in the Cotton Belt, differing in habits of growth, size of bolls, earliness, abundance, and length and uniformity of

staple. Staples are from five-eighths to 1 inch long, and some varieties reach $1\frac{1}{8}$ inches in length when grown under favorable conditions. The 1-inch and $1\frac{1}{8}$-inch lengths usually command a premium over the shorter lengths.

Soil.—Grown on practically all well-drained soils in the Cotton Belt. Most productive soils are the dark-colored clay lands, particularly those rich in lime, such as the black prairies of Alabama, Mississippi, and Texas, and the red, brown, and black, well-drained, river-bottom land and the second bottoms such as are found in Mississippi, Tennessee, and Arkansas. The sandy loams of the coastal plain and the red subsoil piedmont lands, when fertilized, also give high yields of cotton. The red prairie of Texas and Oklahoma, east Oklahoma prairie, and part of the Grand Prairie and Edwards Plateau of Texas are also productive soils.

Climate.—A frostless season of 190 to 200 days and an average temperature during the summer months of about 77° F. appear to mark the northern limits of commercial cotton production. The southern part of the Cotton Belt has a frostless season of 250 or more days and an average summer temperature of 85° or more. Even with a frostless season of 200 days and sufficient late summer temperatures, the planting of cotton is attended with risk if the months of May and June are cool and wet or have cold nights, as this retards the normal germination and growth of the plant. The average annual rainfall in the belt where cotton is grown without irrigation ranges from 15 to 20 inches in the panhandles of western Texas and Oklahoma to 60 inches in southern Mississippi. A precipitation of 30 to 40 inches per year, about half occurring in the winter and early spring, the rest distributed through the growing season, and the fall months dry, makes ideal conditions for cotton production.

General Farm Practices.—Times, methods, and costs of preparing land, of planting, cultivating, picking the cotton, and preparing it for market vary much in different parts of the South. Wherever grass or weeds grow profusely in the fields the cultivation of cotton requires from one to three handhoeings per season. With one mule a man can plow, chop, and hoe from 10 to 20 acres. One-mule implements are used over the greater portion of the eastern part of the Cotton Belt, and in some sections the topography of the land would make the use of larger implements difficult. In the level, black lands of Texas the hoe work is comparatively small, and four-mule implements are frequently used for preparing the land and two-mule implements for cultivating it. The newest form of cotton cultivation has developed in the irrigated districts of the Southwest. Here the essentially distinctive features are leveling the land, so that the entire field may be irrigated uniformly, and regulating the water so as to obtain the desired results.

Although fertilizers are being used for cotton in all the States east of the Mississippi River the heaviest use is on the soil of the coastal plains of North Carolina, South Carolina, and Georgia, and to a considerable extent upon the soils of the piedmont region of these States. In recent years the use of fertilizers has extended into Arkansas and Texas. Various combinations of acid phosphate, kainite, muriate of potash, and nitrate of soda are generally used. In many regions the greatest outlay of cash in producing the crop is for fertilizers, which, after labor, make the most important factor in the cost of production.

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In the southern part of the Cotton Belt cotton planting begins about March 1, and the date of planting becomes later going north to the northern border of the belt where it begins in the latter part of April or early in May. In the irrigated valleys of the Southwest, upland cotton is planted during April and May, and the Pima Egyptian cotton in southern Arizona is planted in the latter half of March.

Cotton picking begins early in July in southern Texas. Through the center of the Cotton Belt it begins in the latter part of August and along the northern border about September 15. In the irrigated valleys of the Southwest cotton picking begins about the middle of September.

Cotton Improvement—*American production.*—The American crop falls far short of what it should be both in yield per acre and in quality of product. It has been estimated that American production is only 50 per cent efficient. This condition is due largely to the following causes:

The planting of seed of several different varieties in the same neighborhood; the intercrossing of these varieties in the fields; the mixing of seed at the public gins; and the general use of gin-run seed for planting. Such seed is often of low vitality, results in poor stands and in mixed stocks, and grows many unproductive plants and many that yield fiber of poor, irregular quality.

The public gins hold over a large quantity of seed from each customer and pass it on to the next. Experiments have shown that as much as 26 per cent of the seed delivered to the farmer at the public gins, as usually operated, may be seed of another variety ginned for the previous customer. If such mixed seed is planted, there is much cross-pollination in the field by insects that visit the flowers.

In a recent boll-weevil questionnaire sent to farmers throughout the Cotton Belt there was included a request for the name of the variety of cotton being grown. From a total of approximately 13,000 replies 438 different names of cotton varieties were reported.

The crossing of different varieties in the field develops a mongrel stock of seed that produces irregular fiber and is the chief cause of the popular idea that cotton varieties "run out" in a few years and that fresh seed must be brought in from other districts. The fact is, however, that selected seed stocks of good varieties that have not been allowed to become mixed have been grown continuously in the same districts for many years with no indication of "running out" as long as selection of the planting seed and clean ginning are maintained.

The continued production of low-quality fiber may be attributed also in a large measure to the failure on the part of the cotton buyers in the primary markets to pay more for better cotton when buying from the farmers. This practice has led farmers to believe that the most desirable character that a variety can have is a high lint percentage or large "outturn at the gin." As a matter of fact, most of these high-lint-percentage varieties produce short and inferior fiber and have small, light seeds that yield a low percentage of oil.

Localities producing irregular fiber of low quality soon establish a bad reputation in the minds of cotton buyers. Although such cotton can be sold, it usually brings a lower price than uniform fiber that is available in large commercial quantities from localities that have established a reputation for producing good cotton.

Foreign competition.—Every season of high cotton prices increases the interest in cotton production in other countries. In the last few years representatives from

many foreign governments have come to the United States to study the American cotton industry. In many of these countries labor is cheap, and on the present high wage costs and low efficiency of American production cotton can be put upon the American and European markets from these countries for less money than it can be produced and sold in the United States or elsewhere.

The effect of this competition from other countries will be felt first by the American growers of low-quality, short-staple cotton. Since about half of the cotton crop is exported to other countries, American growers must protect their own industry by producing better cotton and through large yields produce it more cheaply than other countries in spite of our higher cost of labor.

Improved cultural methods.—Under boll-weevil conditions the real problem of the American cotton farmer is to produce the largest possible crop in the shortest possible time. In other words, it is a race between the cotton grower and the boll weevil. To increase his chances of producing a profitable crop in spite of this pest, the farmer should follow the most improved methods of farm practice. Both production and quality of the present crop of American cotton can be improved and the improvement maintained by application of the latest approved methods of culture and by the production of adequate supplies of pure seed of superior varieties. The application of improved cultural practices and the establishment of centers of pure seed production are essential.

Recommendations.—The cotton council of the United States Department of Agriculture and the Association of Southern Agricultural Workers unite in emphasizing the following points in recommendations for the improvement of cotton production:

(1) Planting only on fertile, well-drained land.
(2) A well-prepared, settled seed bed.
(3) Liberal fertilization and increased use of quickly available nitrogen.
(4) Purebred, selected seed.
(5) One-variety communities.
(6) Full stands.
(7) Closer spacing.
(8) Shallow, clean cultivation.
(9) Practice of approved methods of weevil control.
(10) Careful picking and ginning.
(11) Prevention of country damage.
(12) Rotation of crops and the use of legumes for soil improvement.

Preparation of Soil.—No set rule can be laid down governing the preparation of the seed bed. This will be influenced by the type and topography of the soil, the crop previously grown, seasonal conditions, and available implements. Flat breaking in fall or early winter is desirable, especially on heavy soils not subject to washing, and where land has been planted for some time continuously in cotton. Five or six inches is sufficiently deep to break land for cotton. On lighter soils bedding in rows of the desired width some time before planting seems to answer every requirement. Preparation should be early enough to give a firm, smooth, well-settled seed bed at planting time.

Fertilizers.—The use of commercial fertilizers can not safely be recommended in regions of scant summer rainfall, but elsewhere it has generally proved profitable in the production of cotton. Applications of 200 to 800 pounds per acre are recommended by the experiment

stations of practically all the States in humid territory, according to type of soil and natural fertility. The formulas now most used for cotton fertilizers are variations of 8–3–3 or 8–4–4, the figures representing the percentages of available phosphoric acid, nitrogen, and potash. A higher potash content is ordinarily needed in very sandy soils or where wilt is present than in clay loam soils or sandy loams with a friable red clay subsoil. In the latter soils the use of phosphoric acid and nitrogen alone frequently gives satisfactory results. Fertilizers are applied to best advantage just before or at planting time. An additional application of 100 to 200 pounds of nitrate of soda or other form of quickly available nitrogen as a side dressing is a practice now generally recommended. This is usually applied immediately after cotton has been chopped and hoed. In the Delta soils of Mississippi and in similar types nitrogen in a quickly available form is the only fertilizer commonly used.

Planting.—Cotton should not be planted until it is reasonably certain that danger from frost and cold is past, and the ground has become warm enough to cause prompt germination and vigorous early growth. Heavy seeding and shallow planting are very necessary to insure a full stand. Not less than 1 bushel, and preferably 1½ bushels, of seed per acre should be planted. Graded and delinted seed will germinate sooner and produce healthier, more uniform, and more vigorously growing plants than ungraded and untreated seed.

Spacing.—Width of rows should be 3 to 4 feet, depending on the fertility of the soil. Rank growth may be prevented if the plants are left closer together in the rows than was customary in former years. Early maturity and larger yields are generally obtained from the leaving of two or three stalks together in hills a hoe-width apart. The spacing recommendation of the Association of Southern Agricultural Workers is 8 to 12 inches and one to three stalks in the hill, dependent on soil and average seasonal conditions.

Cultivation.—Shallow and frequent enough to keep free from weeds and grass. Where cotton ridges are not too high, a cultivation with the weeder or section harrow before cotton comes up and one or two cultivations of the same kind immediately after the cotton is up are effective in killing weeds and grass, preventing a crust from forming, and starting young cotton to growing vigorously. During severe boll-weevil infestations it is advantageous to continue the cultivation of cotton for two or three weeks beyond the usual "laying-by" time. Great care must be taken, however, as careless or deep cultivation, particularly at this time, may cause the plants to shed much of their fruit.

Weevil Control.—If weevils are numerous at the time cotton is just beginning to square, destroy all adult weevils, either by hand-picking or poisoning, as may be most practicable. At this stage the molasses and calcium-arsenate mixture can be used effectively instead of dust, if more convenient. When squaring begins, especially if not equipped to poison by dusting, pick and destroy all punctured squares from the ground and the stalks once every week to 10 days for a period of about 30 days. Then, if weevils are still numerous or as many as 10 to 15 per cent of squares are infested and other conditions warrant, apply the calcium-arsenate dry dust poison. In making applications of the dust poison always follow carefully directions of the United States Department of Agriculture and the college of agriculture of your own State.

Picking and Ginning.—Cotton should be picked clean, and when mature and dry, and kept dry until ginned. If not thoroughly dry when ginned the staple is cut and damaged, sometimes to the extent of several cents per pound. The same thing will happen if the gin saws are out of alignment or the saws are bent so that some of them drag or rub against the ribs, or if some of the teeth are dull or broken or the saws are revolving at too great a speed. More care is necessary to gin the upland long staples without injury than the short-staple varieties. Roller gins are used to gin very long-staple cotton such as sea island and Egyptian.

One-Variety Communities.—The only practical way to protect the purity of seed of improved varieties of cotton is in organized communities devoted to the production of only one variety of cotton with the gin as the community center. When all the farmers understand the behavior of one variety, improved methods of culture are most easily followed in relation to differences in soil, season, and time of planting, as well as to the control of insect pests and diseases, labor supplies, ginning, handling, warehousing, financing, and marketing of the crop.

In some localities it may be difficult to decide upon the one best variety to grow, but after careful tests and discussion at farmers' meetings of the relative merits of the varieties a variety may be selected by popular vote. Separate ginning facilities must be provided, or the ginner who handles the local production must pledge his support to the organization and agree to gin only the one kind of cotton produced by his community.

Community Pure-Seed Farms.—A sufficient quantity of pure seed of the selected variety should be obtained to plant the entire gin-center community the first year and all the old mixed stocks sold to the oil mill.

In the best selected varieties inferior off-type plants or "rogues" always show up here and there in the field. If these inferior plants are allowed to remain in the field, crossing takes place with the good plants and the seed becomes mixed, so that in a few years the effect on the crop may be nearly as harmful as when different varieties are grown in the same locality.

Since it is not to be expected that many of the farmers in a community will have the facilities or take the trouble to protect their fields by pulling up these inferior plants and selecting their planting seed, each community should have a pure-seed farm, where the roguing and selection work can be carried forward and the seed stocks for general planting can be developed.

In every community there is usually at least one farmer who has the facilities and who can be persuaded to undertake the production of stocks of pure seed in the interest of the community, or a group of neighboring farmers who will assume this responsibility. The next step is to plant, in addition to the general crop, a 1-acre patch of the selected variety separated from any other cotton fields by at least 300 yards.

To facilitate inspection and recognition of the normal type of the variety, the plants should be spaced more widely than in the field plantings, or at least 12 to 14 inches apart. Every grower of pure seed must become familiar with the type of plant of his variety, and at least three times during the season he should inspect the

patch carefully and destroy all the plants that he can detect as not true to type.

Some of the off-type plants are more readily distinguished in the early stages, and it is important to remove as many of the rogues as possible before the flowering stage and thus avoid crossing of the normal plants. Some of the rogues are difficult to detect until the fruiting stage is reached, when flower and boll characters can be examined. Hence, early and late inspections are necessary in order to remove such plants.

The final selection is made when the crop of the breeding patch is fully matured and opened. Examination of the lint and seed characters may still show a few off-type plants that could not be detected from the external characters.

The pure-seed farmer should then select a sufficient number of the most typical and most productive plants to provide pure seed to plant a similar 1-acre patch the following year, requiring about 42 pounds of seed cotton.

Many farmers attempting to select seed for planting purposes fail to appreciate the need of strict adherence to the type which is one of the most important principles of successful cottonseed selection. Selection by type is different from mass selection of good plants from mixed stocks, which never reach a condition of uniformity. A plant may appear very fruitful; but if it is not true to type, it should not be included in the selection. Plants are often found that have a large crop of bolls, but with the bolls closely clustered on short-jointed fruiting branches. Such plants may make an attractive appearance in the field, but usually have shorter or more irregular fiber, and their progeny often show greater abnormalities.

The selected plants can be marked with large white tags to avoid any mistake in picking; and if possible, the cotton should be ginned on a small hand gin in order to keep the seed pure. The selection can be made still more effective if the seed of the best individual plants is picked and ginned separately for planting in separate rows, so that the progeny can be compared in the next season; but this is work for the professional breeder rather than for the farmer who is maintaining seed stocks for his community.

After the best plants are picked the remainder of the 1-acre patch is harvested to form the first increase stock of seed. Arrangements should be made with the local ginner to handle this seed cotton after the regular crop ginning is completed, when the gin can be cleaned and the seed caught on the floor under the gin stand to prevent mixture with other seed stocks.

Increase of pure-seed stocks the second year.—On the basis of about one-half bale of lint to the acre the bulk seed from the 1-acre block should plant approximately 15 acres the following season. The community breeder should arrange his plantings the second year, therefore, to provide for two separate plantings, namely, the 1-acre patch of his selected seed as well as the 15 acres of increase stock. As in the previous year, the 1-acre patch should be examined during the season and all off-type plants destroyed. In the fall he should again select sufficient seed for a 1-acre patch, the remainder serving for a 15-acre increase planting.

The 15 acres grown from the first increase of the original 1 acre should also be examined early in the season, and again before picking time to remove any off-type plants that may be found. This block should produce enough seed to plant approximately 225 acres the fol-

lowing season. Special care should be taken to gin separately the cotton from the 15-acre planting as well as from the 1-acre planting each year.

Increase of seed stocks in the third year.—At the beginning of the third year the community breeder will have three stocks of seed. He will have selected seed for his 1-acre breeding block, his first-year increase stock for a 15-acre field, and a second-year increase stock for planting 225 acres. He has now established the connecting links between the breeding patch and the pure-seed supply for the community. From the 1-acre patch he selects each year his planting seed for a similar breeding block. The remainder of this patch goes into a 15-acre increase planting; the 15-acre field provides the seed for a 225-acre field; and the seed from this planting is ample for the needs of an average gin community. In three years, therefore, the community has provided for a continuous supply of pure seed, and so long as full support is given to the program there is no reason to suppose that the quality and uniformity of a cotton variety can not be maintained indefinitely.

Handling of community seed stocks.—During the three years required to establish the local seed-production program the community has been producing cotton of the same variety from the seed stocks purchased in the first year of the community organization. Although the quality of this seed after the three seasons is not equal to the select stock now available from the community breeder, its deterioration has been less rapid than in mixed-variety communities because the local ginner has been handling only the one kind of cotton.

At this stage arrangements must be made to dispose of all the old stocks of seed and to replace them with the supply of seed from the 225-acre increase of pure seed in the hands of the community breeder. The basis on which the community is to be supplied with the good seed should be decided upon at the time of organization. Preferably, the seed should be available to the community at oil-mill prices plus the cost of care, separate storage, handling, and insurance.

When a continuous supply of pure planting seed is being produced each season by the community breeder, the only remaining problem in relation to seed stocks is an equitable arrangement for the disposal of any surplus of select seed that may be sold to outside farmers or to newly organized communities. It has been found best to pool the community surplus and pro rate among the farmers the proceeds of any sales so that each farmer's share is in direct proportion to the quantity of seed he has contributed to the pool.

Community Warehousing.—Realization of the advantages to be obtained from cooperative warehousing of cotton has led to the organization in all the cotton-growing States of farmers' associations to finance the building of centralized, fireproof warehouses for the proper storage and handling of the crop. Through these associations the farmer receives protection for his lint from damage by fire and weather; his crop is marketed in an orderly manner; and a fair price is assured for the quality of cotton he produces. Full benefits from such associations can not be realized, however, in communities growing many different varieties of cotton. Though the progressive farmer producing a superior staple from selected seed may receive a premium for his cotton the first year or two, there is no possibility of maintaining the high

quality of his crop so long as his neighbors persist in producing inferior cotton from mixed seed and ginning their crop in the same gin. It is also difficult to get full price for the better staple because it is available only in small quantities.

A real improvement in production and quality of American cotton will come only in well-organized communities devoted to the growing of one pure variety, to maintenance of the quality and uniformity of this variety by improved methods of culture, continuous selection of the planting seed, clean ginning, and cooperative marketing of the crop year after year in the large commercial quantities of uniform fiber that manufacturers require.

Fiber Flax

General.—Hemp and fiber flax are the only fiber-producing plants, aside from cotton, that give promise of commercial success in the United States. Flax includes two different forms or groups of cultivated varieties, namely, seed flax and fiber flax. Fiber flax is an annual herbaceous plant with straight, erect stalks 30 or 40 inches tall and three-thirty-seconds inch or less in diameter, bearing simple, narrow leaves and a few short branches near the top. The bright blue flowers are followed by nearly spherical capsules containing brown seeds. The fiber is found in the inner bark of the main stem.

Distribution.—Practically all the seed may be traced back to Russia. In the United States it is grown in eastern Michigan and in the Willamette Valley in Oregon.

Climate.—Requires a cool, moist climate. It is a 90-day crop and may be grown where the season is too short for most other field crops. Warm, dry weather ruins the crop for the production of spinning fiber. It is more subject to lodging from wind and beating rain than most other crops.

Soil.—Clay loams, sandy loams, or even sandy soils with some humus and not subject to drought will produce good crops of flax. The heavier soils usually give a heavier yield, and the lighter soils produce finer fiber.

Fertilizers.—So far as demonstrated in this country, the best fertilizer is barnyard manure applied to a previous crop. Direct application of commercial fertilizer is likely to produce coarse, uneven stalks and ruin the crop.

Rotation.—May follow clover or pasture that has been fall-plowed, or corn or other intertilled crops provided they have been kept free from weeds. Grows well after hemp because of the absence of weeds. Rarely does well after small grains.

Seeding.—Prepare the land more thoroughly than for any other field crop in order to insure uniformity of growth. Sow with a drill or seeder, covering the seed with not more than three-fourths of an inch of soil. Sow at the rate of 70 pounds (1¼ bushels) per acre, but this rate may be increased for very fertile, moist land. Roll after seeding to pack the soil around the seeds, which will insure prompt and even germination and leave a smooth surface, which is an advantage in harvesting. In Europe fields of fiber flax are often weeded by hand, but that is not done in the United States.

Harvesting.—Harvest about 90 days after seeding, or after the leaves fall and the stalks turn yellow, and when most of the seed bolls have turned from yellow to brown and the seeds are brown and hard. It is pulled and bound

in bundles by hand at the rate of about one-fourth acre per day, or by flax-pulling machines at the rate of about 4 acres per day, or cut with self-rake reapers at the rate of about 5 acres per day. Pulled flax produces better fiber and better seed than cut flax. Set up the bundles of flax in shocks to cure for a period of 5 to 10 days. Then draw them directly from the field to the scutching mill, and stack or store in sheds.

Deseeding.—Thresh or deseed by holding the stalks by hand and pass the tops two to five times between revolving belt pulleys which crush the seed bolls. Clean the seed by running it through a fanning mill. More efficient combined flax-threshing and seed-cleaning machines are coming into use.

Retting.—In eastern Michigan flax is dew-retted by spreading it on the ground exposed to the weather for two to six weeks. It is often too dry and cold for dew-retting in the fall, so most of this work is done the following spring and early summer. In Oregon nearly all the flax is water-retted in tanks supplied with water from a creek. This work has to be discontinued in winter because the water is too cold. Much has been published about chemical retting, but thus far this has not been developed into commercial success.

Breaking.—After retting and drying the stalks, break by feeding them endwise, a handful at a time, through fluted rollers with an interrupted motion. This breaks the woody interior part into small pieces called shives.

Scutching.—The fiber coming from the brake is held by hand, first one end and then the other, over the edge of a notch in the scutching stall, where it is beaten by the revolving blades of the scutching wheel, which scrape away the loosened shives. This work requires skill. Three or four different kinds of combined breaking and scutching machines are being tried, but they are not yet in general use. The scutched fiber is made up into hands and baled for market.

Yield.—Production of dry fiber flax straw with the seed ranges from 1½ to 3½ tons per acre. This yields 4 to 6 bushels of seed and 200 to 500 pounds of scutched fiber.

Use of Poor Crops.—Because of unfavorable weather conditions and unsuitable soils an average of at least 20 per cent of the total acreage of fiber flax grown is too short or is lodged and tangled, so that it can not be used for the production of spinning fiber. This is cut with mowing machines, raked up with hayrakes, and without being retted it is put through a series of fluted rollers, which thresh the seed and soften the straw for upholstering tow.

Market.—Flax fiber is not quoted in the United States. It is used by a number of spinning mills located chiefly in the districts tributary to Boston and New York. The prices for scutched fiber range from 20 to 30 cents per pound, which are much higher than pre-war prices.

Consumption and Demand.—Previous to 1914, the annual consumption of flax fiber in the United States ranged from about 8,000 to 10,000 tons, nearly all of which was imported from Russia. Since the war the importations have been only 5,000 to 8,000 tons annually, but there has been little demand for American flax.

Equipment.—The production of flax fiber requires special equipment as follows: Seeding machinery or modified grain drills, a flax-pulling machine or self-rake reaper for

each 100 acres, a scutching mill with threshing, seed-cleaning, breaking, and scutching machinery for each 500 acres. If the flax is water-retted, tanks are required with a supply of soft water.

Organization.—The scutching mills are usually operated by a company which supplies the seed and all special equipment, selects the fields, and contracts for acreage. The grower is usually paid on the basis of the weight of straw and seed delivered at the scutching mill. The prices paid for the straw in recent years have ranged from $20 to $35 per ton.

Hemp

General.—Hemp fiber, formerly the most important material in homespun fabrics, is now most familiar to the purchasing public in this country in the strong, gray tying twines one-sixteenth to one-fourth inch in diameter, known by the trade name "commercial twines." Hemp is an annual herbaceous plant belonging to the hemp family, which includes two species of hops and one species of hemp. It grows from the seed with an erect central stalk 3 to 12 feet high and one-eighth to 1½ inches in diameter, branching and leafy if grown in hills for seed production, and without branches or leaves, except a few at the top, when crowded in broadcast sowing for fiber production. The fiber, like all bast fibers, is produced in the inner bark of the stalk. It contains numerous strands extending from the surface of the ground to the ends of the main stalk and branches. The fiber is gray in color, if dew-retted, and creamy white, if water-retted. The strands of hemp fiber composed of innumerable overlapping cells three-sixteenths to 2⅛ inches long and 0.003 to 0.012 inch in thickness, are 2 to 10 feet in length, and usually flat, and three thirty-seconds inch or less in width.

Distribution.—Native of central Asia and cultivated as early as 2700 B. C. In the United States it is cultivated in Wisconsin, Illinois, and Kentucky, and it has been grown in recent years in Michigan, Ohio, Indiana, Iowa, Minnesota, and California.

Climate.—Grows best in a moderately cool, temperate climate. Not cultivated for fiber production in warm countries. Hemp seedlings will endure cold or even slight frosts as well as seedling oats or other early spring crops, and mature hemp will endure temperatures 6° to 8° below freezing (F.) without apparent injury. Abundant moisture is required in the early stages of growth, but after the root system is well established hemp will endure drought as well as other field crops of the humid climate. Lack of moisture cuts down the yield and impairs the quality of the fiber. Warm, moist weather is required for dew-retting between harvest time in September and the beginning of winter. Clear, dry weather is required for threshing the seeds of seed hemp, and also for hand breaking. Hailstorms are often injurious to young hemp, but wind and rain that beat down grain rarely injure hemp.

Soils.—Hemp requires a fertile clay loam soil. In Kentucky it is cultivated only on clay loams and silt loams overlying the Lexington limestone of the blue-grass district. In Wisconsin and Illinois it is grown chiefly on Carrington loam and to a less extent on Clyde loam. It often grows well on muck lands, but produces a very poor crop of fiber.

Fertilizers.—Best fertilizer is stable manure applied to the preceding crop. Any fertilizer applied to the hemp crop itself is likely to result in coarse, uneven stalks.

Hemp improves the physical condition of the soil, destroys weeds, and when retted on the ground where it grows, it returns most of the fertilizing elements. It leaves the land in excellent condition for any succeeding crop and especially for crops in which weeds may be troublesome.

Rotation.—Hemp should follow corn or other intertilled crops, clover, or grass and pasture. It should not follow small grain.

Seeding.—Prepare the seed bed by plowing in the fall on grass or clover land and disking in the spring. Corn ground may be spring-plowed, disked, and harrowed. Sow early in the spring at about the time of sowing oats in the same region. Seed at the rate of about 1 bushel per acre, or a little less on poor soils or more on very fertile soils. Grain drills or preferably hemp drills with tubes 4 inches apart give better results than broadcasting by hand.

Harvesting.—Cut about four months after seeding or when the staminate plants are in full flower. A hemp harvester cuts and spreads the stalks for retting at one operation. This machine, driven by a tractor, and two men to operate it, harvests 8 to 12 acres in a day. A self-rake reaper drawn by a tractor, with two men, averages about 5 acres per day. Self-rake reapers leave the stalks in gavels on the ground. In Kentucky, where self-rake reapers are used, the gavels of stalks are picked up and set in shocks, and spread for retting later.

Retting.—In the United States all hemp is dew-retted. It is spread on the ground in thin, uniform layers and left exposed to the weather for 4 to 10 weeks, or until the bark, including the fiber, separates easily from the woody interior portion of the stalk. When retted sufficiently the dew-retted stalks are picked up from the ground, "lifted," either by hand or by a machine which ties the stalks into bundles. In Kentucky the retted stalks are set up in shocks without being tied in bundles. Elsewhere the bundles of retted stalks are drawn from the field to the scutching mill where they are stacked in large sheds.

Breaking and Scutching.—In Kentucky, hemp is broken on hand brakes in the field. These brakes crush and break into small pieces the interior woody part of the stalks. The fiber is there scutched or cleaned by being whipped across the brake and freed from the loosened hurds. This work can be done only in clear, dry weather. In the North, hemp is broken and scutched in the winter when more labor is available, and the work is done inside of buildings free from interference of the weather.

Scutching Mill.—First pass the stalks through artificial driers 100 feet or more in length. Feed endwise through a brake consisting of 10 to 15 pairs of heavy fluted rollers. Upon coming from the brake the fiber is turned sidewise and grasped near the center by carrying belts which take it past three pairs of large scutching drums. These drums, revolving outwardly on each side of the carrying belts, beat away the loosened hurds and short or weak fiber. The long fiber is delivered sidewise, clean and straight. It is sorted into three grades and baled for shipment. The tow beaten out by the scutching drums and also that produced from short or tangled stalks is cleaned by a tow machine, consisting of fluted rollers, beating cylinder, and shakers.

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Yield.—Under favorable conditions in this country, the yield per acre may be estimated as follows:

	Pounds
Stalks, green, freshly cut	15,000
Stalks, dry, as cured in shock	10,000
Stalks, dry, after dew-retting	6,000
Fiber, long line, scutched hemp	650
Fiber, tow	350

Equipment.—A hemp-scutching mill, completely equipped, costing from $25,000 to $70,000, will handle the hemp from 250 to 500 acres. A hemp harvester is needed for each 100 acres, and about as many gather binders.

Organization.—Hemp-scutching mills are usually operated by a company or an organization of hemp growers. This company or central organization contracts for acreage, furnishes seed, superintends the work, and furnishes machinery for harvesting and picking up the stalks. The grower is paid either on the basis of the weight of retted stalks delivered at the scutching mill or on the basis of the quantity and quality of fiber produced from the stalks.

Prices.—The market prices for American hemp fiber in recent years have ranged from 6 to 11 cents per pound for tow and 12 to 20 cents per pound for line.

Market.—Hemp is used in a number of spinning mills in this country. The annual consumption of hemp in these mills previous to 1914 ranged from about 5,000 to 8,000 tons, about half of which was water-retted hemp from Italy. There was practically no demand for American dew-retted hemp from 1920 to 1923 inclusive, but there was a keen demand at good prices in 1924 and 1925 and a weak market in 1926.

Seed Supply.—All the seed of American hemp is produced in a small area in the valley of the Kentucky River. Imported seed has resulted in failure. Most of the hempseed now produced in Kentucky is from seed of improved strains developed by the United States Department of Agriculture by selection at Arlington Experiment Farm.

Henequen

The largest quantity of binder twine is made of fiber obtained from the leaves of the henequen plant. This fiber is commonly known in the trade as "sisal," because it was formerly shipped from the port of Sisal in Yucatan, but it is different from the fiber of the true sisal plant. Henequen is a native of southeastern Mexico and is also cultivated in Cuba. It is rarely seen outside of these regions. The plants produce seeds and bulbils, similar to top onions, but they are propagated chiefly by suckers which grow from the rootstocks. The suckers are set out in rows about 9 feet apart and about 6 feet apart in the row. The first crop of leaves is cut four to seven years after the suckers are planted, and after that annual or semiannual crops are cut for 10 to 20 years. Only the two outer or lower rows of leaves are cut at each harvest, the others being left to develop. The spines on the point and margins are trimmed off and the leaves tied in bundles of 50 each and taken to the cleaning machines. After being cleaned the fiber is dried in the sun and is then ready to be baled for the market. This fiber is of a light reddish-yellow color and is 3 to 4 feet long. It is delivered at the mills in the United States, where it is made into binder twine.

Jute

The name jute is used to designate the fiber taken from two closely related plants, India jute, *Corchorus capsularis,* and desi jute, *C. olitorius.* Both plants are cultivated in India, southern China, and southern Japan. Practically all of the jute fiber of commerce is produced in India, chiefly in Bengal. Most of it is grown in rich alluvial soils in the lower Ganges and Brahmaputra Valleys. From 2,500,000 to 3,500,000 acres are devoted to this crop in India every year, yielding 8,000,000 to 11,000,000 bales of fiber of 400 pounds each.

The land for jute is dug up by hand or plowed several times and harrowed with wooden " ladders " until it is as fine and uniform as the best market gardens in the United States. The seed is sown by hand at the rate of 20 to 30 pounds per acre for the India jute, or 12 to 18 pounds for the finer seed of desi jute, and covered very lightly. The crop is usually thinned and weeded twice before it is 30 inches high.

When the plants are 6 to 10 feet tall and in flower, 4 or 5 months after seeding, they are harvested, either being cut by hand or pulled up by the roots. They are tied in bundles with bands near the top and bottom. The tops are cut off and, if pulled, the roots are also cut off. The bundles are placed in artificial pools or in water along the margins of slow-running streams, and weighted to keep them under water, but they must not touch the bottom. With water at 70° to 80° F., they ret in 10 to 20 days. When the stalks are retted so that the bark, including the fiber, slips easily from the woody inner part, laborers wade into the water waist deep, break the stalks by beating them with mallets, then strip off the fiber, and clean it by whipping it on the surface of the water.

The fiber is hung on bushes or poles to dry. It is afterwards tied in bundles and sold in the local market, usually passing through the hands of several middlemen before reaching Calcutta. The flaggy lower ends are cut off, forming the jute butts of commerce. The long fiber is sorted into about 4 grades, and both long fiber and butts for export are packed by powerful hydraulic presses into dense, uniform 400-pound bales.

The yield of fiber ranges from 1,000 to 1,600 pounds per acre. Since 1920 the prices of jute butts and rejections used most extensively in this country for cotton bagging, have ranged from 3 to 11 cents per pound, and the long fiber from about 6 to 15 cents in the United States.

Numerous experiments have demonstrated that jute will grow well in rich alluvial soils in the Southern States, but the fiber can not be produced profitably here by the laborious hand methods of India. Many machines have been devised to prepare jute fiber, but thus far they have not proved efficient enough to compete with the Indian methods.

Jute is the most easily spun, cheapest, weakest, and least durable of the important fibers of commerce. It is used in larger quantities than all other plant fibers combined, except cotton. Cotton bales are covered with jute bagging. Pacific coast grain is stored and shipped in jute sacks. Jute burlap and gunny sacks are used for potatoes, peanuts, rice, sugar, coffee, stock feed, fertilizer, wool, and many other agricultural products. There are about a dozen jute-spinning mills in the United States,

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but most of the jute products are imported in partly or wholly manufactured condition.

Sisal

The true sisal fiber is obtained from the leaves of the sisal plant, a native of southern Mexico, cultivated in tropical Africa, Java, and Sumatra. For profitable fiber production it should be cultivated in limestone soils in regions where the temperature does not fall below freezing. It is not cultivated in the United States. Sisal produces suckers and bulbils, as does henequen, but no seeds. The bulbils, and usually the suckers, are cultivated six months or more in a nursery before being set out in the field. When 15 to 20 inches high they are transplanted to the field and set in rows 6 to 9 feet apart. The first crop of leaves is cut three to five years after the transplanting, and annual and semiannual crops are obtained for 4 to 10 years thereafter. The best sisal is cleaned by machinery in the same manner as henequen. When properly cleaned it is clear, ivory white, with a good luster, and it is stronger than henequen. Well-cleaned sisal commands a price somewhat better than henequen, and it can be used to better advantage in higher grades of cordage than binder twine.

FORAGE CROPS

General

Forage has an important place in our system of farming. If the term "forage" is given its original meaning, that is, concentrates and roughage for livestock, seven-tenths of the 365,000,000 acres of land in the United States occupied by crops harvested in the census year 1919, or approximately 257,000,000 acres, were used to produce forage. In addition to the crop land there are about 1,055,000,000 acres of permanent pasture. More than half of the pasture is, however, arid western range, and nearly a fourth more is forest and cut-over land. This explains why the pastures, although they occupy more than four times the area devoted to harvested forage, furnish about the same proportion of the total sustenance of our livestock as do the crops.

Roughages may be classified as hay, fodder, straw, stover, silage, root crops, and soilage. If the value of a roughage is estimated according to the number of livestock it will support for a year, the different hays rank as follows: (1) Alfalfa, (2) clover, (3) timothy, (4) wild or native grasses. Corn and sorghum are the leading fodder crops, and corn also provides more than 95 per cent of the silage made in the United States. Among the straws, oat is the most valuable, followed in order by wheat and barley. In the production of stover, corn is again first, and the value of this item is large if the stover consumed by animals pastured in cornfields after the ears have been husked from the standing stalks is taken into account. True root crops such as mangels, rutabagas, and turnips are unimportant in the United States, larger numbers of livestock being supported by such items as beet pulp, potatoes, and sweet potatoes. Soilage, or roughage fed in a green state, is also unimportant, and not often resorted to except on dairy farms when there is a lack of silage or other succulent feeds. About 3,000,000 acres of crops are "hogged-off," that is, mature crops harvested by the turning of animals into the field to graze on it. In the Northern States the crops "hogged-off" are mostly corn and a considerable acreage of soy beans; in the South, peanuts, cowpeas, soy beans, and velvet beans grown alone or mixed with corn; and in the West, field peas, particularly in Colorado and Wyoming.

Grasses

Bermuda Grass.—Important pasture grass in the South, where it shows marked preference for clayey soils, but grows more or less abundantly on sandy soils. Occurs northward as far as Maryland, Kansas, and the warmer valleys of Washington and Oregon. In Virginia and Maryland, where it is more troublesome as a weed than valuable as a forage, it is commonly called wire grass. The three important varieties are Common Bermuda, St. Lucie, and Giant Bermuda. The usual rate of seeding is 5 pounds per acre. In humid regions it produces seed very sparingly and so is commonly planted by pieces of the rootstocks or stolons. Good seed is produced in abundance in Arizona, California, and Australia. It is a native of the warmer portions of the Old World, probably coming from either India or the Mediterranean region.

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Johnson Grass.—Adapted to that part of the United States south of latitude 38°. In this region it has occupied the better soils, particularly those of limestone origin, and has made the production of other crops on these soils difficult and expensive. This is because of the fact that Johnson grass is supplied with rhizomes or underground stems which make it very difficult to eradicate. Where it already occupies the land Johnson grass may be utilized profitably as a hay crop, but it does not make a good permanent pasture. Pasturing weakens the grass considerably, and one of the best ways of eradicating it is to keep it closely cropped or grazed off for one or more seasons and then to plow it up and devote the field to some cultivated crop. Johnson-grass hay is nutritious and the yields are heavy on good soils. It can not be grown profitably in the Northern States or on poor, thin soils anywhere.

Kentucky Blue Grass.—Most noted grass in America, with the possible exception of timothy. It is well known for the beautiful lawns that it makes as well as for the highly nutritious pasturage which it furnishes. Blue grass occurs throughout the northern half of the United States, except where the climate is too dry. In the mountains and on the Pacific coast lowlands it extends farther southward. It is supposed to have a special liking for limestone soils, but recent investigations indicate that this is not primarily on account of the lime but because of the general richness of the soil. It is an abundant grass on all good soils, regardless of the presence of lime. It blooms but once a season. Seed is harvested mainly in Kentucky but to some extent in Missouri and Iowa. Special stripping machines are used in harvesting, and the seed is dried carefully so as to prevent heating, which seriously weakens its germination. The usual rate of seeding is 14 to 18 pounds per acre. Blue grass is a native of the Old World, where it occurs naturally throughout much of Europe and Asia. It was brought over by the early colonists as one of the species contained in mixed grass seeds.

Orchard Grass.—Well-known grass grown in nearly every State in the Union and very commonly in the region east of the Mississippi River and north of Alabama and Georgia. It attains most importance, however, in Kentucky, southern Indiana, North Carolina, Virginia, West Virginia, and Maryland and seems thoroughly adapted to a variety of soils in these States. In the timothy region it is looked upon unfavorably, but where timothy can not be grown successfully orchard grass is used extensively and is considered of very good quality. If the seed is sown at the rate of 2 bushels per acre, so that it makes a thick stand, the quality of the hay will be much improved. Orchard-grass hay is fairly good feed for horses, but is more valuable for cattle, especially for fattening them for the market. For pasture it gives the best results when mixed with other grasses and clovers and is of special importance because it grows early and late in the season. Seed is produced to the largest extent in Jefferson, Oldham, and Shelby Counties, Ky., Clark County, Ind., Loudoun and Fauquier Counties, Va., and in some of the counties adjoining these in the States mentioned. The average yield of seed is 10 to 12 bushels per acre. The usual rate of seeding is 25 pounds per acre. Orchard grass is a native of Europe and was first cultivated in Virginia.

Redtop.—No other grass will grow under as great a variety of conditions. It is the best wet-land grass among the "tame" species and will grow on soils so very poor in lime that most other grasses fail. Strongly drought

resistant and is often used for holding banks to prevent erosion. Second only to blue grass as a pasture plant in the northeastern part of the country. Vigorous grower and will form a good turf in a short time. Matures at about the same time as timothy. Will thrive from Canada to the Gulf of Mexico and from New York to California. Though often used in lawn mixtures, its use by itself as a lawn grass is not to be recommended. Will add to the yield of a timothy and clover-hay crop, but is considered objectionable by buyers of market hay. Most of the seed is produced in southern Illinois, and is sold in two grades, known as chaffy and recleaned. The recleaned should be purchased, as it is more economical, and there is less danger of its containing noxious weed seeds. The seed is small and requires a mellow seed bed and a light covering of soil. May be seeded in early spring or late summer. When it is seeded alone 10 pounds per acre are needed. From 4 to 5 pounds per acre are sufficient to use with other grasses for hay, and 2 to 3 pounds are enough to use in pasture mixture, as it spreads readily under favorable conditions. It was early introduced into the American colonies.

Sudan Grass.—In leaf, stem, and seed characters Sudan grass resembles Johnson grass very closely, but it lacks the underground stems or rootstocks which make Johnson grass difficult to eradicate. Grown in all parts of the United States, except the deserts, the high altitudes of the mountain regions, and in the New England States. Being an annual grass with a short growing season it is an emergency hay and pasture plant. In the humid part of the United States where soy beans thrive, a mixture of Sudan grass and soy beans not only yields well, but the hay is peculiarly adapted to feeding dairy cows. It provides a way of making up a deficiency of hay to supplement the pasture or silage ration. A seeding of 10 to 12 pounds of Sudan-grass seed with 4 or 5 pecks of soy beans per acre usually gives the desired stand. Few grasses are so well adapted for use as a summer pasture. The seed is comparatively inexpensive, germination is prompt in warm soil, and the early growth is vigorous. The carrying capacity in humid regions is easily one mature cow or horse per acre from the time the grass is 8 to 10 inches tall until frost stops the growth. Cattle, sheep, horses, and hogs all relish Sudan-grass pasture and thrive on it. It makes very nutritious and palatable hay, yielding 2 to 4 tons per acre, and under irrigation yields as high as 8 to 10 tons are not uncommon. A slight element of danger from prussic-acid poisoning exists in pasturing this grass, but injury to livestock occurs only when the grass is damaged by drought or frost. No fatalities have ever been reported from the humid regions where the grass has made a normal growth. The usual rate of seeding is as follows: Broadcast or in drills, 20 to 25 pounds per acre; in rows, 4 to 6 pounds. The grass was imported from Khartum, Sudan, Africa, in 1909.

Timothy.—By far the most important hay grass cultivated in America. The extent of its culture is more than three times as great as that of all other hay grasses combined and nearly equal to that of all other hay plants, including clover and alfalfa. Well adapted to the northern half of the United States and to the mountainous regions somewhat farther southward. The southern limit of its successful culture is approximately the same as the northern limit of cotton culture. It is adapted to fertile loams, silt loams, and clay loams, and

gives best yields on fertile, moisture-retentive soils. It does not do so well on sandy or droughty soils or on poorly drained lands. The usual rate of seeding is 15 pounds per acre. It is generally conceded that timothy is an introduced species.

Wild or Native Hay Grasses.—The wild-hay crop is gradually becoming relatively less important, because the acreage has remained practically constant during the last decade while that of most other forage crops increased. The native grasses still contribute, however, an important part of our hay supply, ranking fourth among the hay crops and seventh in the list of all crops producing forage. It was the wild grasses that made it possible for the pioneer to take his livestock with him when he went west into the unsettled areas. At present the northern Great Plains and contiguous portions of the spring-wheat belt constitute the most important native-hay area of the United States. In the eastern part of this section Big Bluestem, Little Bluestem, Bluejoint, Indian grass, and Switch grass are the most important native hay grasses. West of the one hundredth meridian western wheat grass, slender wheat grass, side-oats grama, and other species of Bouteloua are increasingly important. The native or wild grasses are even more important for pasture than for hay.

Legumes

Alfalfa.—At the present time there are recognized in the United States several fairly distinct commercial strains of alfalfa varying in their adaptations to climatic conditions, some giving the best results in the North and Northwest, and others succeeding only in the South and Southwest where the winters are mild. The leading commercial varieties are Common, Grimm, Peruvian, Cossack, Canadian Variegated, and Argentine. Other varieties of less importance are Baltic, Turkestan, Provence, Sand Lucern, Arabian, South African, and Yellow-flowered.

Common.—Under the term "common" alfalfa is included the greater part of the alfalfa grown in this country. Most of this is from seed that was brought to California from Chile about 1850. The seed from the various sources is usually designated by the name of the State where, or the condition under which it was produced. It varies considerably in hardiness and in other characteristics. Where it has been grown for several seed generations in the North, it has acquired characteristics which render it more resistant to winterkilling than where it is grown farther south. Whether this is due entirely to selective acclimatization, or in part to actual adjustment of individual plants to local conditions is not very definitely known. At any rate, in the purchasing of seed, an effort should be made to procure it from a locality where the winters are approximately as severe as the winters in the region where the seed is to be sown.

Argentine.—Strain of common alfalfa received in this country in considerable quantities during the last few years. Seed is produced under climatic conditions less severe than the climate of Kansas. Not suitable for use in the Northern States.

South African.—Recently seed of common alfalfa has been received from South Africa in commercial quantities. Preliminary tests indicate that seed from this source is at least no hardier than the Argentine or Kansas common alfalfa.

Provence.—Strain of alfalfa originally grown in southwestern France. Classed as an original strain of common alfalfa and not as a distinct variety. Similar

to Kansas alfalfa in adaptation. Not commercially important in this country.

Turkestan.—Introduced into the United States from Turkestan in 1898. Until very recently most of the alfalfa seed imported into this country has been from that source. The variety, although variable, resembles common alfalfa rather closely in its general characteristics. Selected strains have proved equal, if not superior, to the ordinary alfalfa in hardiness and drought resistance, but the commercial importations as a rule are decidedly inferior, especially for the humid districts.

Grimm.—Introduced into the United States in 1857 by Wendelin Grimm. Result of a natural cross between the purple and the yellow-flowered alfalfa. Owes its superior hardiness in part to its yellow-flowered ancestry and in part to the natural selection that has taken place under the severe climatic conditions to which it has been subjected since its introduction into this country.

Cossack.—The Cossack and Cherno are hybrid varieties introduced from Russia in 1907. Because of their similarity both now are usually catalogued as Cossack. Cossack alfalfa has variegated flowers, is resistant to cold, and is adapted to about the same conditions as Grimm alfalfa, but has given no indication of being much if any superior. The grower is therefore not justified in paying more for seed of Cossack than for Grimm.

Canadian Variegated.—Similar to the Grimm and Baltic varieties in the color of its flowers and in its general habit of growth and compares very favorably with them in yield of seed and hay; more resistant to cold than the common variety, and in the humid districts of the East seems to be about equal to Grimm. Much of the seed imported into the United States is grown in the vicinity of Silverdale, Ontario. It commands a slightly higher price than common alfalfa, although generally selling for somewhat less than seed of the Grimm.

Baltic.—Similar to Grimm alfalfa and has been developed in much the same manner. The name Baltic was first applied to it in 1906, for the reason that it had been grown near Baltic, S. Dak., for several years, and not as has been supposed because of its introduction from the Baltic Sea region of Europe. Comparative tests have not shown the Baltic alfalfa to have any particular advantage over the Grimm, and as a result it is no longer of much importance.

Sand Lucern.—A hybrid alfalfa which is undoubtedly the parent of our selected strains of variegated alfalfas, such as Grimm, Baltic, and Canadian Variegated. Variable in resistance to cold and drought. Not commercially important in this country.

Peruvian.—Tenderest and most rapidly growing of our commercial varieties. First introduced into the United States from Peru in 1899. Seldom survives the winters where the temperature falls below 10° F. and therefore suited only to the South and Southwest. Not drought-resistant, and is not recommended for dry-farming sections. Two strains are recognized, namely, Smooth Peruvian and Hairy Peruvian.

Arabian.—Introduced from Arabia in 1902. Plants are typically more hairy, a little shorter in growth, and somewhat more bushy than the ordinary alfalfa, short lived, and not cold-resistant. Succeeds only in our Southern and Southwestern States. Not commercially important.

Yellow-flowered.—Sometimes referred to as Siberian alfalfa, but the name is misleading, since not all the

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yellow-flowered alfalfas come from Siberia. As a rule these alfalfas produce light yields of hay and because of their habit of low growth are difficult to harvest. Though they may have some value for breeding purposes, they are of little use to the average farmer.

Rate of sowing.—In the humid States the rate of sowing varies from 20 to 25 pounds per acre. Under dry-farming conditions 8 to 12 pounds is advised and under irrigation 15 to 20 pounds.

Time of cutting.—Cut when plants are well in bloom in order to prolong the stand and to obtain the largest yields. Cuttings made at an earlier stage possess a somewhat higher feeding value because of the higher protein content and the smaller quantity of fiber. This difference is not sufficient to offset the advantages gained by cutting at a later stage. When winterkilling is a factor make the last cutting of the season early enough to permit considerable fall growth for winter protection. Avoid cutting young stands until the plants are in bloom, even though the fields are weedy. Clipping checks the weed growth, but it also checks the root development of the alfalfa seedlings.

Seed production.—Commercial seed production in this country is confined largely to those regions that have little rainfall. Ordinarily, alfalfa sets seed very sparingly under humid conditions, hence it is more profitable for the eastern farmer to purchase seed that is produced in the West than to grow it himself.

Cultivation.—Cultivation has little effect on the yield and longevity of alfalfa. Under irrigation, however, cultivation sometimes is beneficial in loosening soil that has been compacted by the tramping of cattle or in breaking up silt deposits.

Red Clover.—Most important leguminous forage and soil-improving crop in the northeastern quarter of the United States. Will grow on any well-drained, fairly rich soil that has plenty of lime in it. Most common method of seeding is on winter grain, but it also is often seeded with spring grain. Late summer seeding is successful in much of the southern and eastern part of the clover area. If seed is sown broadcast, 10 to 15 pounds should be used per acre, but if drilled only 6 to 8 pounds are needed. Often seeded with timothy, though sometimes with other grasses. With timothy the hay of the first crop year is mostly clover; the second year the timothy is most heavy, and after that the clover largely disappears. Clover is most used in rotations with a cultivated crop and a small-grain crop in three, four, and five year rotations. Use high-quality seed. Seed usually is taken from the second crop.

Red-clover failure.—Due to various causes, the contributing or controlling factors being lack of drainage, lime, phosphate, or potash. Disease also causes failure, especially in the southern margin of the clover area. Seed grown in Italy has proved to be worthless in the eastern half of the United States, since the plants winter-kill or die from disease. Where severe winter conditions, without adequate snowfall, prevail, plants grown from seed imported from some foreign country may also suffer severely, but this seed may be used in other sections. Where disease is more dangerous than winter cold, disease-resistant strains should be used. Resistance to disease can be acquired only where the disease is prevalent; hence, seed from the northern United States may be no better in disease-infected sections than imported seed. The remedy lies in home-grown seed, especially in sections where only resistant or partially resistant plants can survive. The one outstanding fact

that has developed from the study of red-clover strains is that in most places locally grown seed is the safest.

Alsike Clover.—Companion crop to red clover and is most at home in northern latitudes or in the South, on river and creek bottom lands. Thrives best in a cool, moist climate. In the Ohio Valley it is especially adapted to low, wet, fertile land. On such land it will yield heavy crops of first-class hay and will make more than one crop in a season. Will grow on "sour" land on which red clover does not thrive. Mixed with red clover on uplands, it insures a stand on spots where red clover does not catch. It is used mostly in mixtures with timothy or other grasses, a common formula being alsike clover, 1 part; red clover, 1 to 2 parts; timothy, 2 to 3 parts, and 8 to 12 pounds of such a mixture per acre. In such mixtures it improves the hay and increases the yield. The grasses serve to support the clover and make it easier to cut and cure. Will endure overflow that would kill most crops. Has been known to grow a year in water-soaked and water-covered soil and make a heavy growth. Good pasture plant, often remaining in a permanent pasture for many years. It is a good clover to seed in swales or on wet natural meadows. It volunteers readily and will spread in such places. Its disadvantages are: (1) On uplands it grows short and does not make a mass growth equal to that of red clover; (2) it makes no second crop except on low, rich land; (3) on uplands after hay or a seed crop has been cut the pasturage is too small to be useful; and (4) there appears to be some danger to horses and mules of a little-known disease said to result from eating alsike clover.

Bur Clover.—Bur clovers are valuable agriculturally only in regions where the winters are comparatively mild, such as the cotton-growing area of the South and all the Pacific coast west of the Cascade and Sierra Nevada Mountain ranges. Mostly utilized as a soil improver and as pasture for hogs, cattle, sheep, and poultry. Horses and mules ordinarily refuse to eat it. Bur clover alone is sometimes used as a green-manure crop in the deciduous orchards of California, but mostly as a natural volunteer crop. In the South the great value of bur clover is due to the fact that it is the cheapest and most easily handled legume that can be used as a combination cover and green-manure crop, especially in cotton growing. Yields 2 or 3 tons of hay per acre. In sowing use 5 bushels of seed in the bur to the acre, together with 2 bushels of winter oats or 1½ bushels of wheat. Hairy vetch is much preferred to bur clover. The chief objections to bur clover are: (1) Relative unpalatability of the plant, (2) small amount of growth, and (3) the fact that burs become entangled in the wool of sheep and thus reduce its value, particularly in the range country.

Crimson Clover.—Fall-planted annual, widely cultivated in the Middle Atlantic and Southeastern States for forage, a cover crop, and green manure. Often sown in corn at the last cultivation, 15 pounds of seed per acre being used. If the soil is heavy, a better practice is to sow after a crop of small grain or on other land that can be specially prepared. Will grow on poorer soil than most clovers and is not particularly dependent upon lime. For this reason it has been widely used for restoring the productivity of soils which have been abused. A more important function is to maintain crop yields on soils that are moderately rich. The most common difficulty in growing it is the killing of the young stands by drought.

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This is best prevented by the preparation of a fine, moist, and firmly compacted seed bed. August, September, and October are the best months for sowing, the exact date depending upon the latitude and the condition of the soil. Either hulled or unhulled seed may be used, the latter giving somewhat greater certainty of stand. Often sown with a nurse crop of buckwheat or cowpeas to protect it from the sun. A light covering of straw is also effective. Combinations with oats, hairy vetch, or other fall-sown forage crops give somewhat higher yields and a surer stand than crimson clover alone. Commercial seed of American origin is grown mostly in Tennessee, but some is produced in Delaware and Maryland. Most of the seed in this country is imported from Europe.

Mammoth Clover.—Larger and later in maturing than common red clover. Also known as bull clover, big clover, and sapling clover.

White Clover.—Important crop for pasturing. Spreads by means of creeping stems, which take root at the nodes or joints. If a light seeding is made and the young plants are somewhat far apart, they will increase gradually. The stand is further thickened by seed produced while the crop is being pastured. A number of hard seeds are produced and may remain in the ground for two or three years before germinating. When a stand is badly thinned during a dry season it recovers rapidly on account of young plants springing up from these dormant seeds. White-clover pasture can be much improved by application of phosphates.

Ladino Clover.—A variety of white Dutch clover that grows much larger than the common kind and where conditions are suitable produces a superior hay or abundant pasturage. Needs good land and plenty of moisture. Thrives best under irrigation and has become established in the Snake River Valley in Idaho, where it seeds well and where a seed-growing industry has developed. This variety deserves trial as a plant for permanent pastures on good bottom lands east of the ninety-eighth meridian.

Subterranean Clover.—A Mediterranean clover that has been brought to the United States by way of Australia. Shows promise of being valuable as a winter grazing crop in parts of the South, but has not yet become established.

Cowpeas.—Best known and most extensively grown leguminous crop in the Southern States, although it can be grown profitably much farther north. Grown mainly for forage and to improve the soil, but the seeds of the Blackeye and White varieties are used for human food. Will do best on sandy loams, but will succeed on nearly all kinds of well-drained soils. Poor or unproductive soils should be fertilized with about 300 pounds of acid phosphate and 50 pounds of potash per acre. Most valuable varieties are the Whippoorwill, Groit, New Era, Brabham, and Victor for seed or hay. The Iron, Brabham, and Victor varieties are highly resistant to wilt and nematode diseases. Plant seed about two weeks after corn-planting time. For seed production sow in rows about 3 feet apart, placing seeds from 2 to 3 inches apart in the row, and using about 30 to 45 pounds per acre. For forage or green manuring sow broadcast or in drill rows 6 to 8 inches apart, using 75 to 120 pounds per acre. May be grown in combination with other crops, such as sorghum, Sudan grass, Johnson grass, or millet. These mixtures produce a larger yield of hay, which is more easily handled and cured, and constitutes a better ration. Can be used to good advantage in almost any system of rotation. As a summer annual the cowpea is brought into competition with velvet beans and soy beans,

but succeeds for general purposes under a greater diversity of conditions. Cowpea seed during recent years has been high priced, and in localities well suited to seed production it will be found highly profitable to grow seed on a large scale.

Field Peas.—Widely grown in Canada but are of minor importance in the United States. Can be grown successfully only in a cool climate, and as a summer crop thrives only in the States bordering on the Great Lakes, the Pacific Northwest, and the high altitudes of the Rocky Mountain region. Deserves wider use as a winter legume in the Southern States. Best yields are made on clay loams. The best early field pea is the French June, the best midseason variety the Golden Vine, and among the most popular late varieties are the Canadian Beauty and the Blue Prussian. Of the newer varieties the Carleton, Kaiser, Bangalia, Paragon, and Gregory are valuable. As a winter green-manure and cover crop the ordinary varieties are valuable only in southern California and along the Gulf Coast. The varieties known as Gray Winter and Austrian Winter are, however, able to withstand much lower temperatures than the ordinary varieties. In sowing small-seeded varieties use 1½ to 2 bushels per acre, for medium-sized seeds use 2 to 2½ bushels, and for the large-seeded use 3 to 3½ bushels. Do not cut for hay until the pods are well formed, and for grain not until the earliest pods turn yellow. Pasturing with sheep or hogs has been found profitable in the San Luis Valley in Colorado. Sown in mixture with rye or oats it makes an excellent early hay crop. The seed has been used with success as a concentrate in feeding rations for the production of both meat and milk. Because of its effect on the fertility of the soil, it is valuable in crop rotations, and its use as a substitute for summer-fallow in the wheat-growing regions of the Northwest is advised.

Lespedeza or Japan Clover.—Valuable forage plant for the southeastern part of the United States, but it is known to reseed in southern Ohio and Indiana. Native of eastern Asia and introduced into this country before 1846. Produces a good hay crop on rich bottom lands and in Mississippi even on sandy cut-over lands. In the northern part of the Cotton Belt it is a pasture plant and thrives on a great variety of soils. It is also a good soil improver. Is sometimes a constituent in permanent pastures of Bermuda grass and carpet grass. Will reseed itself even under grazing conditions. Recommended for use in crop rotations wherever it makes sufficient growth to be cut for hay. In the South oats may be harvested and a crop of lespedeza either for hay or seed grown on the same land in one season. Several strains or varieties are known, among others the Kobe, a recent introduction from Japan, and Tennessee No. 76, an upright-growing, late variety. Segregations also appear to take place naturally, since plants grown from Tennessee commercial seed are very different from those grown from seed produced in Louisiana and Mississippi. The Korean lespedeza is a new species and is much earlier. It will ripen seed as far north as Chicago, and is promising as a pasture plant on the poorer soils of the Ohio Valley.

Sweet Clover.—Grows wild or cultivated in practically every State in the Union. Largest acreage is found in the western North Central States and in the Mountain States. The white species constitutes a very large percentage of the present acreage of sweet clover. The annual yellow species should be sown in no part of the

country except the South and the Southwest. Sweet clover is adapted to a wider range of climatic conditions than any of the true clovers and possibly alfalfa. Will grow on practically all soil types, provided the soil is not acid and is well inoculated. More drought-resistant than red clover, and more resistant to alkali than alfalfa. Lime requirement is as high as that of red clover or alfalfa. Usually will respond to applications of fertilizers and manure.

Good stands in the more humid sections are obtained by seeding with a nurse crop, using 15 to 20 pounds of hulled seed per acre. Only seed which germinates 75 per cent or more should be used in the spring of the year. Does best when seeded on a well-firmed seed bed which has only sufficient loose soil on the surface to cover the seed. Provide inoculation in some form. Spring seeding is generally satisfactory, but in the South an excellent stand is also obtained from mid-winter seeding. Early fall seedings are usually successful south of the latitude of southern Ohio. The increasing use of this crop for pasture is the outstanding fact in recent years. Throughout the summer months it will carry twice as many cattle per acre as a good stand of blue grass. When sown early in the spring it may be cut for hay in the fall and the subsequent growth turned under the next spring for corn. In the Dakotas and Minnesota, hay from the second-year crop has under certain conditions been found to mold, and this moldy hay has sometimes produced an hæmophilous condition of the blood so that animals have died from internal bleeding. Care must therefore be taken in feeding hay of this kind. Hubam is an annual variety of white sweet clover. Arctic is an early variety of biennial white sweet clover developed in Saskatchewan. Grundy County is an early, more slender variety, commercialized in Grundy County, Ill. The annual yellow species (*Melilotus indica*), also known by various common names, is a winter annual, grown as a green-manure crop in citrus orchards in California, in sugar plantations in Louisiana, and generally on the better lands throughout the South. Will not thrive on the poorer coastal plain lands unless the soils are heavily limed and fertilized.

Soy Bean.—Native of southeastern Asia, and introduced into this country as early as 1804. The extensive utilization of the soy bean for forage and the increased use of the beans for oil and human food have resulted in an enormous increase in the acreage of the crop. Climatic requirements are about the same as those of corn. More drought-resistant and less sensitive to an excess of moisture than cowpeas and corn. Succeeds best on fertile sandy loams and clay loams. Inoculate seed unless it is sown on land previously planted to this crop. Plant the same time as corn. With rows 24 to 40 inches apart use 25 to 40 pounds of medium-sized seed per acre, and when sowing broadcast use 90 pounds. Variety planted should be adapted to local conditions. About 45 varieties are now handled by growers and seedsmen. The most important are Biloxi, Black Eyebrow, Chiquita, Dixie, Elton, Guelph, Haberlandt, Hahto, Hollybrook, Ito San, Laredo, Lexington, Mammoth, Manchu, Mandarin, Mid-west, Mikado, Otootan, Peking, Tarheel Black, Tokyo, Virginia, Wilson-Five, and Wisconsin Black. May be combined in many systems of crop rotation, or grown as a main crop. In combination with other crops, such as corn, cowpeas, and Sudan grass, the soy bean furnishes a well-balanced ration, a large yield, and a greater variety of forage. The large yield of seed, the ease of harvesting it, and

the increasing demand for the beans for planting purposes, for food, and for production of oil and meal recommend it for seed production. Feeding value of the seed compares favorably with that of other concentrated feeds. Straw obtained from soy beans threshed for seed is a valuable feed for all kinds of livestock. Soy-bean hay has a high feeding value, from 1 to 3 tons per acre being produced. Makes good pasture, the most profitable method being to "hog-off," supplementing the corn ration. Mixed with corn, 3 parts corn and 1 part soy beans, it is excellent for silage. As yet, the soy bean has no important enemies—insect or disease.

Miscellaneous.—*Kudzu.*—Long-lived leguminous vine succeeding in various types of soil in the eastern half of the United States. Advisable to plant only where the field can remain in this crop for many years. Setting well-rooted plants about 10 feet apart each way is the best method of establishing a field, as seeding is too expensive and generally unsuccessful. Usually good crops are not obtained until about the third season. May be used as pasture, for soiling, or for hay.

Mung bean.—Grown mainly in Asiatic countries for the seed, which is an important article of food in the form of bean sprouts and bean vermicelli. Late varieties of the mung have given promise as a forage plant in many sections of the Southern States. In yields of forage and seed it does not compete with the better varieties of soy beans and cowpeas. Has been found resistant to the attacks of the Mexican bean beetle.

Peanut.—Native of the Tropics and grown in about 12 of the Southern States. Has much the same climatic range as cowpeas. The peanut is a pea rather than a nut and belongs to the same group of plants as do beans and common garden peas, differing mainly in that it possesses the character of blooming above the ground and maturing its fruit, or pod, beneath the surface of the soil. The crop is important for forage. It is estimated that 1,000,000 acres are "hogged-off" annually and about 300,000 acres cut for hay. Peanut meal is esteemed very valuable as an ingredient of concentrated feeds for dairy cows. Peanuts are used in rotation with cotton and other farm crops in the fight against the boll weevil. They are adapted to growing on sandy loam and light loam soils especially. Usual planting distance is 28 to 42 inches between rows, averaging about 32 inches. Seeds of the Spanish and other upright varieties should be planted 7 to 10 inches apart in the row. Plant seeds of the Jumbo and larger-growing varieties 10 to 14 inches in the row. Seed may be planted either shelled or in the pod. Use 36 to 45 pounds per acre for planting the Spanish variety in the pods, and 12 to 18 pounds for Jumbo shelled. Seeds planted in the shell may be soaked 24 hours before being planted. Shelled seed should never be soaked. Early cultivation may be handled with one-horse spring-tooth weeder. Make later cultivation with riding cultivators or one-horse walking cultivators. Peanuts are not subject to any serious diseases but often are injured by grasshoppers and army worms.

When grown for the market they should be cured in stacks around poles with crosspieces nailed to the poles about 10 inches above the ground. In stacking place the pods next to the pole, keeping the center of the stack high to shed water, drawing stack to a tapering point when it is about 5 to 6 feet in height. Peanuts

should cure in stacks for at least six weeks. Remove the pods from the vines by means of picking machines or by hand, and store in loosely woven burlap bags. Keep in a dry, well-ventilated place, and protect from rats and mice.

Velvet bean.—Most vigorous-growing annual legume cultivated in the United States. Adapted especially to the well-drained portions of the Atlantic and Gulf Coastal Plain areas. Will make a fair to good growth on the heavy clay soils in the northern parts of the Cotton Belt. With the development and introduction of early varieties, such as the Georgia, Alabama, Arlington, Tracy, and Yokohama the culture has been extended much farther northward. Usually planted with corn, either in the same row or in separate rows, two rows of corn to one of beans being the most popular method of planting. Use about 2 or 3 quarts of seed per acre. The yield of corn may be decreased slightly by the beans, but their value for green-manure and feeding purposes will be much greater than the loss to the corn crop. The most important use of the velvet bean is as a grazing crop for cattle and hogs in fall and winter. Best annual-legume crop grown in the South for soil improvement. On account of the extensive tangled growth of vines it is necessary to pick the beans by hand, the usual yield in pods being one-half to 1 ton per acre. Excellent as part of the rations of beef cattle and dairy cows. Feeding experiments show that 2 to 2½ pounds of velvet beans in the pod are equal to 1 pound of high-grade cottonseed meal.

Vetches.—Grown chiefly on the Pacific coast, around the Great Lakes, and in the Southeastern States. Several kinds of vetch, the most important of which are the common or spring vetch and the hairy vetch, make excellent feed, either green or as hay. Are exceedingly useful as cover and green-manure crops. Sixty pounds of common vetch seed or 30 pounds of hairy-vetch seed is enough for 1 acre. Usually enough seed of some small grain, such as rye or oats, is added to make a thin stand of the grain to support the vetch. Vetch requires well-drained soil to succeed and does best in loams or sandy loams, but grows well in sandy or gravelly soils, if inoculated. Inoculation is essential where vetches are sown for the first time. With seed at a reasonable price, hairy vetch is the best winter legume for all localities in the eastern half of the United States where red clover fails or where crimson clover is not a success. The purple and the black bitter vetches are proving to be excellent green-manure crops in California. Woolly-pod vetch is similar to hairy vetch and much earlier, but is not so hardy, though more hardy than common vetch. Hungarian vetch is excellent on the Pacific coast and succeeds better than any other variety on poorly drained land. Narrow-leaf or Augusta vetch is naturalized in the Atlantic Coast States and Southern States and is valued as a constituent of pastures.

Millets

Utilized in the United States as emergency hay or catch crops, but Sudan grass is rapidly encroaching on them in this field. Adapted to a wide range of soils and climates. Valued in semiarid regions because their short growing season often enables them to escape periods of drought. Useful in ridding a field of weeds. Usually sown on spring plowing because of their use as catch crops and planted about two or three weeks after corn-planting time. In humid regions use 25 to 30 pounds (about 2 pecks) per acre, and in semiarid districts 10 to 15 pounds. Use a grain drill or broadcast the seed. German, Hungarian,

Common or Golden, Siberian, and Kursk are the principal varieties. Barnyard or Japanese and Pearl millet or Penicillaria are grown in a small way. The hay has about the same feeding value as timothy hay. Injury has resulted when millet hay was used as a continuous ration for horses. It is slightly laxative and also acts as a diuretic (affecting kidneys). Not suitable for pasture purposes. Can be used in almost any rotation where a spring-sown crop is required, although it is not valuable as a constituent of crop rotations. The acreage devoted to millets has decreased rather than expanded during the last two decades, being less than 50 per cent of what it was in 1909.

Meadows

Timothy and red clover form the basis of hay growing on good soils in the northeastern quarter of the United States. Alsike clover is better adapted to "sour" and moist soils than common red clover, and the two often are used on uplands mixed together to insure a stand. Redtop is the best wet-land grass, but meadow fescue and timothy will thrive under fairly moist conditions. A good wet-land mixture consists of redtop, meadow fescue, and alsike clover. There are no good poor-land hay grasses. Redtop, orchard grass, and tall oat grass will make a stand on soils of medium productivity, but commercial hay growing requires a rich soil. The best emergency hay plants are the small grains, either alone or in mixture with some legume, such as peas, vetch, the millets, Sudan grass, and, if seeded thickly, sorghum.

Pastures

General.—Pasturage includes all herbaceous feed gathered directly by domestic animals. When the plants are shrubs or trees the pasturage is called "browse." Feed consisting of acorns and other nuts that have fallen from forest trees is termed "mast." This term may include the berries of palm trees and the seeds of pine trees.

Pasturage is important in the support of our livestock population not only because it furnishes approximately 50 per cent of the sustenance required for their maintenance, but because the gains made by cattle on pasture cost about one-fourth to one-half as much as those produced by the feeding of harvested crops. The carrying capacity of our pastures is low. This is because of the poor land which they occupy. Less than one-tenth of our pasture land is suitable for the production of crops, and therefore comparable with crop land in productivity. More than half is in arid regions too dry for crop production; one-fifth is either forest or cut-over land; and more than one-tenth is hilly upland in humid regions, mostly too rough and stony for the production of crops.

Permanent.—Permanent or "long-lay" pastures are those covered with perennial or self-seeding annual plants, usually both, and are kept in grass for a long period of years. Most common on land that can not wisely be tilled. Such lands include steep hillsides, which erode easily, and lands too dry, too wet, too poor, or too remote from markets to produce crops profitably. Two types of grass need to be distinguished, as they differ greatly in character: (1) Bunch grasses, those which grow in clumps and have no creeping branches, (2) creeping grasses, those with horizontal branches either on or below the surface. Typical bunch grasses are timothy,

orchard grass, broom sedge, wire grass, and many of the western range grasses. Characteristic creeping pasture plants include blue grass, white clover, Bermuda grass, carpet grass, and some of the wild short grasses of the West, notably buffalo grass and mesquite grass. Bunch grasses weaken greatly under continuous mowing or constant grazing, so that many of the plants die. Orchard grass and sheep fescue apparently withstand continuous grazing better than the other bunch grasses. The top-dressing of pastures and meadows with manure and proper commercial fertilizers, such as 150 to 250 pounds per acre of acid phosphate, ammoniated phosphate, bone meal, or complete fertilizer, applied when growth starts in the spring, gives a marked increase in hay and pasture. The creeping grasses are rarely killed out by heavy, continuous grazing. Two of the larger creeping grasses, however, like Johnson grass and quack grass, almost disappear under continuous grazing or constant mowing. With creeping grasses or other plants, close grazing is the best practice, provided it is not begun too early in the spring. Bunch-grass pastures must be grazed carefully, as they will not withstand continuous grazing unless it is light or moderate up to the time when seed matures.

Rotation or "Short-Lay."—Rotation or "short-lay" pastures are those sown to perennial grasses, that are left for one to three years and then plowed up. Most important in the Corn Belt and the southern portion of the hay and dairying region north and east of the Corn Belt. The common rotation in these regions is corn, oats or wheat, clover, and timothy, the last frequently being pastured for one to two years before being plowed up for corn. In New England and eastern New York orchard grass, redtop, and the bent grasses partially replace timothy.

Temporary.—Temporary pastures are those used for grazing during a few weeks. Very diverse in type and considered to include various types of crop fields used as pastures for short periods, namely: (1) Fallow pastures—often pastured to keep down weeds as is the common practice in Oregon and Washington; (2) seedling pastures—grazing fields of young wheat, rye, oats, and clover for a time in the fall and winter; (3) stubble pastures—referring to fields other than meadows from which the main crop has been harvested and the stubble and weeds then pastured; (4) aftermath pastures—pasturing hay meadows in the fall after the hay is cut; and (5) crop pastures—pasturing off cowpeas, velvet beans, rape, soy beans, corn, and peanuts when green or approaching maturity.

Tame.—Tame pastures include all rotation pastures and such permanent pastures as are composed principally of tame grasses. The carrying capacity may be increased by an intelligent selection of grasses. This is especially true of the Southeastern States where introduced plants like Bermuda grass, carpet grass, Dallis grass, and Lespedeza or Japan clover are much superior to the native grasses.

Wild.—Native, wild, or natural pastures are areas covered wholly or mainly with native plants useful for grazing. When extensive, such an area is called a "range." The acreage of wild pasture is about ten times as large as the acreage of tame-grass pasture and supplies fully twice as much sustenance. It includes the forest and cut-over land pastures of the more humid portions of the country, the native tall-grass pastures of the praries, the short-grass pastures, and range lands of the Great Plains and other semiarid portions of the West, the bunch-grass areas of the western plateaus, foothills,

mountains, and valleys, and the desert-shrub areas of the arid regions. The carrying capacity of the best humid-prairie pastures along the edge of the Corn Belt is as high as that of tame pasture, but in most of the West from 10 to 100 acres are required to maintain one steer during the grazing season.

Root Crops

Root crops for forage ordinarily include beets or mangels, carrots, rutabagas, turnips, artichokes, and parsnips. Grown extensively for forage in northern Europe and eastern Canada, but are of little importance as forage in the United States. The unimportant place which roots occupy in our long list of forage crops is due partly to the lack of extensive areas that have moist, cool summers, such as prevail in northern Europe, and in part to the large amount of hand labor required in growing and harvesting.

Sorghums

Native of tropical Africa, and grown chiefly in the southern Great Plains and in the dry Southwestern States. Four principal groups of sorghums: (1) Sorgo or sweet sorghum—grown principally for fodder and sirup production, (2) grain sorghums—for grain and fodder, (3) grass sorghums—for hay and pasture, and (4) broomcorn—for its long panicle useful in the manufacture of brooms, yet furnishing some forage after the brush has been harvested. The importance of this introduced crop is even greater than it appears, because of the fact that the sorghums thrive in a region of heavy livestock production where corn and other crops used as forage are uncertain. They therefore provide an insurance against absolute failure of feed in years of extreme drought. The States that lead in sorghum production and their approximate acreage are as follows: Texas, 3,000,000; Oklahoma, 2,000,000; Kansas, 1,500,000; Colorado, 400,000; New Mexico, 320,000; Nebraska, 280,000; California, 180,000; Missouri, 160,000; Arkansas, 90,000; and Arizona, 60,000.

The principal varieties of sorgo are Black Amber, Orange, Sumac, and Honey (Japanese cane). The most important grain sorghums are Blackhull kafir, Yellow milo, and feterita. Dwarf strains of all these varieties of grain sorghums exist and in some crops, as in Dwarf milo, make up the greater part of the acreage. Dwarf kafir is fully as important as the tall or Standard kafir. Dwarf feterita, however, is a comparatively recent production, and its spread is hindered by the poor germination of the seed. Besides these really important varieties of grain sorghums, Dwarf hegari, Durra, or "Gyp-corn," Shallu, and Kaoliang are grown to some extent. Kafir, milo, and feterita seed form the basis of most of the prepared poultry feeds, and when crushed are fed to other kinds of livestock with about the same results as when the animals are fed corn.

Very little difference in the forage yield of sorghum planted in rows 40 inches apart and that sown in close drills, but the cultivated rows are more dependable in seasons of low rainfall. Use about 3 or 4 pounds of seed per acre, except where the rainfall is between 35 or 40 inches use 8 to 12 pounds. Sorghum which has matured, or at least headed, not only makes a better quality of fodder, but is less dangerous to pasture. Both the sweet and grain sorghums are excellent silage crops.

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When the sorghums were first used to fill silos there were many complaints about sour silage. Growers have overcome this difficulty by allowing the sorghum to become more fully ripe before cutting. If cut when the seeds are hard the silage keeps well and is about equal to corn silage in feeding value. For dry, warm climates sorghum is the premier silage crop.

The most serious disadvantage in the use of sorghums as a pasture or soiling crop is the danger of prussic-acid poisoning, for which no effective remedy has been discovered.

Use care in the choice of varieties for forage and for grain. South of the northern boundaries of Tennessee and Oklahoma, Sumac and Honey are the best sorgo varieties, although Orange also produces well. In eastern Oklahoma and Texas, Blackhull kafir is the best grain sorghum, while farther west in these States where the altitudes are higher, Dwarf kafir, Dwarf milo, and feterita are to be preferred. In eastern Kansas and western Missouri, Orange sorgo should be planted for fodder and silage, and Blackhull kafir for grain. In western Kansas, eastern Colorado, and southwestern Nebraska, Black Amber and Red Amber are the best for forage, and Dwarf kafir, Dwarf milo, and feterita for grain. None of the grain sorghum varieties is a reliable producer in northeastern Colorado. Only the very earliest sorgos, like the Dakota Amber and Black Amber, are to be recommended for South Dakota and Northern Nebraska.

Silage

The chief requisite of a crop for silage is its ability to produce tonnage. Along with its high feeding value and palatability, this places corn in the first rank. Sorghums take the lead in the southern Great Plains where the rainfall is not sufficient for corn. Good sorghum silage is about on a par with corn silage. Sunflowers are being utilized as silage where the summers are too cool for corn. Tests have shown that good silage can be made from many other crops.

There is little difficulty in making silage from plants belonging to the grass family, but many of the attempts to make silage from legumes have resulted in a strong-smelling and unpalatable product. Apparently this is due to the fact that the material goes into the silo with too much moisture. When ensiled with corn or the sorghums, cowpeas and soy beans produce silage of high quality. The refuse of pea canneries makes silage much relished by farm animals. Such substances as beet pulp, beet tops, apple pomace, waste from sweet-corn canneries, and sorghum bagasse may be successfully ensiled, or placed in heaps and covered with earth, or if no better provision can be made, massed in large heaps without covering, in which the outside portion on decaying forms a preserving crust. Attempts to ensile cabbage and turnips have failed, the products being ill smelling and watery.

The best time to harvest a crop for the silo is when it is well advanced toward maturity. With corn, this is when the grain is beginning to glaze or to dent, and while most of the lower leaves still are green. Silage is chiefly valuable as a succulent feed to supplement hay and grain rations for dairy cows, and assist materially in maintaining the milk flow. The average quantity fed to a mature animal is 30 to 40 pounds per day.

Miscellaneous

Sunflower.—Native of North America, but has reached its highest development and greatest usefulness in Russia. In Russia and Hungary it is grown for its seeds, which are used for human food and as a source of oil. In the United States seed production is unimportant, but within the last 10 years the Mammoth Russian sunflower, a cultivated variety, has attained some prominence as a silage crop in localities where, on account of high altitude or other conditions, low temperatures prevail during the summer months. Under such conditions sunflowers yield more than corn or sorghum and make a good quality of silage. Tests of sunflowers in the Eastern States, even as far north as Wisconsin and Michigan, indicate that they will hardly compete with corn as a silage crop. In the Great Plains south of the Dakotas, except in the higher altitudes, rust is very destructive to cultivated sunflowers, and they yield less than sorghum. The crop is commonly drilled in rows and cultivated, and is ensiled when most of the plants are in bloom or even before. Sunflower silage resembles in composition silage from rather immature corn; it is somewhat richer in both crude protein and fiber, but furnishes slightly less total digestible nutrients per 100 pounds. It has been fed with fair results to dairy cattle, beef cattle, sheep, and even brood sows. Sunflowers have also been used with success as a soiling crop.

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SUGAR AND SIRUP CROPS

General

Sugar provides about 13 per cent of all the energy obtained from food consumed by the people of the United States. The average quantity eaten is 2 pounds per person per week. This includes the sugar used in candies, sweet drinks, and other foods not prepared in the home. The consumption per capita has increased during the last 100 years from 10 pounds to more than 100.

Sugar Beet

Production.—Commercial production depends upon soil, topography, climate, water supply, control of injurious insects and diseases, and various agronomic factors.

Area.—Sugar-beet areas of the United States lie partly within humid regions, dependent upon rainfall, and partly within the semiarid and arid regions, where most of the crop is grown under irrigation. Sugar beets thrive best in localities where the temperature during the summer (June, July, and August) does not vary greatly from 70° F. Nearly all the sugar-beet factories in the United States are located between the isotherms of 67° and 72° F. summer temperature. Owing to the great variations in altitude in the Western States, these conditions are met with in certain parts of the States as far south as New Mexico and southern California, and in certain parts of Montana and Washington to the north.

There were altogether 105 factories in operation in June, 1926, of which 19 were located in Utah, 18 in Colorado, 17 in Michigan, 11 in California, 9 in Idaho, 5 each in Ohio, Nebraska, and Wisconsin, 3 each in Iowa, Wyoming, and Washington, and 1 each in Indiana, Illinois, Minnesota, Kansas, Montana, Nevada, and New Mexico.

Beets are very sensitive to frost when young, but can stand rather cool weather as they approach maturity. The crop should have a growing season of about five months.

Soil.—Soils have a marked influence in determining the development and distribution of the crop. In the eastern sugar-beet areas the soil is characterized in large part by medium loams to heavy clay, dark to black at the surface, and with clay-mottled subsoils becoming distinctly calcareous at 2 to 3 feet. Two well-defined areas where such soils are found are the region about Saginaw, Mich., and the region extending from southeastern Michigan across northwestern Ohio. In the West a greater variety of soils is used for sugar-beet production. The industry there has been extended to a number of widely scattered areas, each of which has soils more or less peculiar to itself. In general, lighter-textured soils are used than in the East. The greatest acreage is carried on sandy loams, fine sandy loams, loams, and silt loams.

Fertilization.—High soil fertility is required for growing sugar beets. Apply plant food in the form of stable manure, commercial fertilizer, or green-manure crops. In many of the sections where beets are grown under humid conditions considerable quantities of commercial fertilizers

are used with apparently satisfactory results, but scarcely any fertilizer is being used yet in the irrigated districts.

Rotation.—Beets may be grown for several years in succession. However, it results in the accumulation of diseases and insect pests, which eventually destroy or reduce the crop below a profitable basis. The systems of crop rotation vary with the locality and the individual farmer. For example, where dairying is one of the principal industries, more attention is given to the production of feeds of a certain type than upon farms where other kinds of farming are practiced. In general, beans and sugar beets rotate well in areas where both crops are satisfactorily grown. Potatoes and beets are successively rotated in several sugar-beet areas, but care must be taken to avoid the introduction of potato scab, since the same disease attacks both plants. Small grains are satisfactory rotating crops.

Seed.—Sugar-beet seed is imported almost exclusively from Europe. Beets from this seed have little or no resistance to disease peculiar to the United States. Experiments are being conducted to produce strains of beets immune to these diseases. If such strains could be produced, it is believed that a home supply of seed would be assured. Unless varieties distinctly better than those now imported are developed in the United States, it is unlikely that seed growers here can compete with European beet-seed companies, which have the advantage of experience and cheap labor.

Implements.—Many of the implements used for the production of other crops are employed, such as plows, drags, and harrows. A few special implements like the beet-seed drill, beet cultivator, beet lifter, and a special wagon for hauling the roots to the factory or loading station are necessary if beets are to be grown continuously or on a commercial scale. Beet-seed drills usually are constructed so that they will plant four rows at a time. The beet rows usually are from 18 to 22 inches apart and the drills are made so that they can be adjusted to the width of the row desired. Because of the narrow rows special cultivators are made for cultivating beets.

Planting.—Cover the seed to a uniform depth, and make the rows as straight as possible. Crooked rows cause beets to be cut out when cultivated. Thoroughly prepare the seed bed until it has a uniform firmness over its entire surface.

Cultivation.—Cultivate just as soon as the rows can be followed. Then block and thin so that one plant will stand in a place at intervals of from 10 to 12 inches in the row. Cultivate often enough to keep down all weed growth and maintain a mulch over the surface of the ground. Hoe occasionally between the beets in the row to keep the rows clean. When the beet leaves cover the ground the crop is laid by, and no further cultivation is required.

Harvesting.—After the period of cultivation is over, take samples at random throughout the fields and make tests of sugar content and purity. As soon as the sugar in the beet is greater than 12 per cent, and the purity coefficient is 80 or more, the beets are considered fit for harvesting. A purity coefficient below 80 indicates that the beets are not mature and that they should be allowed to remain in the ground for a longer time before they are harvested. Weather conditions greatly influence the maturity of beets, the most satisfactory condition being cool nights and warm days.

The first operation in harvesting is to lift or to loosen the beets from the soil. Then throw them into

piles or windrows. Usually from 12 to 20 rows of beets are used to make one row of piles or one windrow. After the beets are piled, top them and again throw in piles where the ground is free from leaves and other trash. In topping beets, cut them off at the point where the lowest leaves are attached. This operation usually is performed by means of large straight knives, one stroke being sufficient to top a beet. Next load onto wagons and haul to the sugar mill or loading station.

Sugar Cane

Production.—Sugar cane is grown in the United States for sirup production and for the manufacture of sugar. Commercial production depends on soil, topography, climate, water supply, drainage, control of injurious insects and diseases, and various agronomic and economic factors.

Area.—As sugar cane is a tropical plant, grown in the United States somewhat beyond its natural climatic zone, it is here more sensitive to climatic conditions than in the Tropics. It requires a uniformly high temperature, ample sunshine, and a large and constant supply of moisture to keep the plants growing rapidly. In the sugar-cane district of Louisiana the summer temperature averages 81° F. and the frost-free season is more than 250 days. The area for the production of sugar is confined to the Delta region in southern Louisiana (about 100 mills being operated there), southeastern Texas, and southern Florida. The sirup region comprises the majority of the counties in Florida, the eastern half of South Carolina, the southern half of Georgia, Alabama, and Mississippi, central and northern Louisiana, and eastern Texas.

Soil.—The Sharkey clay in its better-drained phases is the principal sugar-cane soil. Other important soils are the silt loam, silty clay loam, and the clay members of the Iberia series, and the fine sandy loam and silt loam of the Oliver series. These are all soils of high natural fertility and have nearly flat surface features. Nearly all of these soils are very retentive of moisture, a feature of considerable importance for the sugar-cane plant, which during its period of rapid growth demands large quantities of water. Light soils and sandy soils are unsuited unless they are irrigated and heavily fertilized.

In addition to high natural fertility and water-retaining capacity of the topsoil, it is essential that the subsoil permit rapid drainage. A stiff, impermeable clay subsoil, particularly if near the surface, holds the water so that the plants will suffer from lack of aeration. On some soils sugar cane will tolerate flowing surface water for long periods, but when the water is standing cane is more quickly injured.

The small patches of sugar cane for sirup making in the Gulf States are planted mostly on soils naturally very productive, such as alluvial lands along streams, depressed areas where the soils are dark, and the more fertile uplands. A lighter-colored and a better quality sirup is produced from cane grown on light-textured, well-drained soils, such as the sandy loam and fine sandy loam types of the Norfolk, Tifton, and Kalmia series.

Drainage.—Cane fields are drained by means of open ditches, which are wasteful of land and expensive to maintain, but because of the character of the soil and the absence of sufficient fall it is difficult to prevent tile drains from silting up. Water from the frequent torrential downpours must not be allowed to accumulate

and stand on the fields, a condition sometimes due to inadequate ditches but more often to neglect in keeping existing ditches clean and in working order.

Rotation.—The growing of sugar cane for the production of sugar is usually the principal and often the only enterprise on the farm or plantation. The cane planter plans to sow one-third of his crop land to cowpeas each year, in order to furnish a green-manure crop which will improve the texture and fertility of the soil. The land intended for cowpeas usually is planted to corn in the spring and the peas sown between the corn rows at the last cultivation.

Fertilization.—The fertility of the alluvial soils of the Mississippi Delta is maintained by the application or commercial fertilizers and the plowing in of green manures. About half of the cane grown in Louisiana receives fertilizer of some kind. The application of commercial fertilizers, when used, varies from 400 to 600 pounds per acre for plant cane and somewhat more for stubble cane. Fertilizer for plant cane is applied in the row at the time of planting. Should only a part of it be applied at the time of planting the rest is used as a side application after the first cultivation. Stubble cane usually is fertilized just after the first or second time it is barred off. On the light-textured soils of the sirup-producing sections heavier applications of fertilizers are made, often 800 to 1,800 pounds per acre, except for the small patches of cane for which sufficient barnyard manure is available or for which the land is especially enriched by the penning of cattle on it before it is planted to cane.

Varieties.—The principal varieties planted in Louisiana are the Louisiana Purple, Louisiana Ribbon, and D–74. All varieties at present grown in the South on a large scale for the manufacture of sugar are of the wide leaf, thick stalk, and relatively soft and juicy types. These varieties have little resistance to root disease or to the recently imported mosaic, and the declining yields of Louisiana plantations have been attributed, in a large measure to these diseases. New varieties resident to these diseases, such as 36 P. O. J., 213 P. O. J., 234 P. O. J., and Cayana, are rapidly replacing the varieties now grown.

Propagation.—Planting material consists of sections of the stalk of the cane. Successive crops obtained without planting are called "ratoon" or "stubble" crops. The "plant" cane, or crop arising from the planting of seed cane, yields a higher tonnage than the succeeding crop of first stubble. In this country it is not customary to permit a crop of second stubble to grow, although it is sometimes done.

Planting.—In Louisiana sugar cane is planted either in the fall or in the spring. The advantage of fall planting is so marked that most of the cane would be planted at that season if it were not for the pressure of other necessary work. Planting is performed with two crews of laborers, one stripping and cutting the seed cane and the other planting. The operation consists in opening the rows, dropping the canes directly from the wagon, cutting the long stalks, and covering by throwing four furrows over each row. The last of the planting operations is the opening of the quarter drains, a system of open ditches, which are necessary because of the heavy rains. Fall planting begins about October 15, and spring planting usually is done in January, February, and March.

Cultivation.—The cultivation of plant cane extends through the spring and summer, from March to July for the native Louisiana cane, and into August for the variety known as D–74. With the latter variety, because of

its upright habit of growth, the rows do not close early and shade the centers well, and hence later cultivation and hoeing are required in order to maintain soil moisture and to prevent weed growth. Except for minor differences in cultivation, owing to variety planted, there is very little difference in the culture of spring and fall planted cane. With stubble cane there is no preparatory labor, the only field operations being tillage and harvesting.

Harvesting.—Operations consist of stripping the leaves from the stalk, topping the cane, cutting it at the ground, and hauling to the station or factory.

Implements.—In the production of cane in Louisiana many special implements are used, including extra-large plows and middle breakers, high double cultivators, stubble shavers, and stubble diggers, and, on some plantations, mechanical loaders. Special hand tools of inexpensive design are used to do the harvesting. Where sugar cane is a minor crop, as it is in the principal sirup-producing sections, the cultivating implements are practically the same as for other crops.

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11. FORESTRY[1]

.0 General (material covering entire subject or several branches not classified elsewhere).
.02 Manuals of forestry, general treatises, essays, addresses, etc.
.03 Dictionaries, encyclopedias, yearbooks, almanacs, calendars, etc.
.04 Biographies.
.05 Forestry periodicals, lumber and trade journals.
.06 Proceedings and reports of societies, associations, commissions, conventions, Federal, State, provincial, and municipal forest officers, etc.
.07 Forest research.
.071 Forest experiment stations.
.072 Research methods.
.08 Forest education. (See also .8713 and .8724.)
.081 Forest schools.
.082 Arbor Day.
.083 Nature study and general propaganda.
.09 History and status of forestry. (See also .87.)
.091 United States (alphabetically by States).
.092 Canada (alphabetically by provinces).
.093 Foreign countries (alphabetically by countries).
.1 Forest botany.
.10 General.
.11 Dendrology.
.110 General.
.111 Anatomy and morphology (including cytology and histology).
.112 Physiology.
.113 Taxonomy.
.119 Miscellaneous.
.12 Forest ecology.
.120 General.
.121 Biological dendrology (reaction of individual trees to environmental factors).
.1211 Site factors.
.12111 Light.
.12112 Temperature.
.12113 Precipitation.
.12114 Humidity.
.12115 Soils—general.
.121151 Soil physics.
.121152 Soil chemistry.
.121153 Soil biology.
.1211531 Bacteria.
.1211532 Mycorrhiza.
.12116 Water relations (transpiration in relation to humidity, soil, water, and temperature).
.12117 Measurement of site factors.
.1212 Seed production.
.1213 Germination.
.1214 Growth.
.12141 Habitus (tree forms).
.12142 Sprouting capacity.
.12143 Root development.

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[1] This classification key was compiled by a committee of the society of American Foresters. It is used in several of the field offices of the United States Forest Service.

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.1 Forest botany—Continued.
  .12 Forest ecology—Continued.
    .121 Biological dendrology—Continued.
      .1215 Acclimatization and adaptation.
      .1216 Phenology.
      .1217 Distribution (geographical).
      .1218 Silvical characteristics (general descriptions, alphabetically by species).
    .122 Silvics (the reaction of tree aggregates to environmental factors).
      .1221 Forest geography and forest descriptions (alphabetically by States, Provinces, regions, or forest types).
        .12211 Climate as influencing vegetation forms.
      .1222 Forest types and site qualities.
        .12221 Basis of classification.
        .12222 Origin and development (migration, invasion, and establishment).
        .12223 Succession.
        .12224 Alternation and zonation.
        .12225 Methods of study and mapping.
    .129 Miscellaneous.
  .13 Regional floras and plant description.
  .14 Accessory forest vegetation.
    .140 General.
    .141 Cryptogams.
    .142 Phanerogams.
    .149 Miscellaneous.
  .19 Miscellaneous.
.2 Silviculture.
  .20 General.
  .21 Silvicultural systems of natural reproduction.
    .210 General.
    .211 Clean cutting.
      .2111 Strips.
      .2112 Groups.
    .212 Seed-tree method.
    .213 Selection method.
    .214 Shelter wood.
    .215 Coppice.
    .216 Coppice with standards.
    .219 Miscellaneous.
  .22 Intermediate cuttings.
    .220 General.
    .221 Improvement cuttings.
    .222 Cleanings.
      .2221 Cleanings by animals.
    .223 Liberation cuttings.
    .224 Thinnings.
      .2241 Rules for thinning a woodland.
      .2242 Rules for cutting.
    .225 Salvage cuttings.
    .226 Pruning.
    .229 Miscellaneous.
  .23 Marking.
  .24 Brush disposal.
    .240 General.
    .241 Piling.
    .242 Top lopping and scattering.
    .243 Burning.
    .249 Miscellaneous.
  .25 Forestation.
    .250 General.
    .251 Seed.
      .2511 Seed production and source.
      .2512 Collection.
      .2513 Extracting and cleaning.

.2 Silviculture—Continued.
.25 Forestation—Continued.
.251 Seed—Continued.
.2514 Testing.
.2515 Storage.
.2516 Treatment.
.252 Direct seeding.
.2521 Methods.
.2522 Protection.
.2523 Results.
.253 Nursery practice.
.2531 Sowing.
.2532 Fertilizing.
.2533 Shading.
.2534 Irrigation, cultivation, and weeding.
.2535 Transplanting.
.2536 Control of growth.
.2537 Temporary storage of stock.
.254 Planting.
.2541 Kinds and classes of plant material.
.2542 Methods.
.2543 Sites and effect of cover.
.2544 Care and protection of plantations.
.2545 For investment.
.2546 For windbreaks and shelter belts.
.2547 For watershed protection. (See also .87112.)
.2548 Shade and ornamental trees, hedges, willow holts, etc.
.255 Costs and cost keeping.
.256 Tools and equipment.
.257 Underplanting.
.258 Tree introduction.
.2581 Introduction of exotics.
.2582 Extension of range of native species.
.259 Tree breeding.
.29 Miscellaneous.
.3 Forest protection.
.30 General.
.31 Fire. (See also .861.)
.310 General.
.311 Prevention.
.312 Detection.
.3121 Airplane patrol.
.313 Suppression.
.319 Miscellaneous.
.32 Animals.
.320 General.
.321 Grazing animals. (See also .91.)
.322 Rodents.
.323 Birds.
.329 Miscellaneous.
.33 Tree diseases.
.34 Insects.
.35 Injurious plants.
.36 Climatic injuries.
.360 General.
.361 Wind.
.362 Snow.
.363 Hail.
.364 Frost.
.365 Lightning.
.366 Sun scald.
.367 Floods.
.368 Erosion (including shifting sand)
.369 Avalanches.

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.3 Forest protection—Continued.
.37 Mechanical injuries.
.370 General.
.371 Logging.
.372 Guy wires, climbers, etc.
.373 Electricity.
.379 Miscellaneous.
.38 Chemical injuries.
.380 General.
.381 Gases and smelter fumes.
.382 Smoke.
.389 Miscellaneous.
.39 Trespass.
.4 Lumbering; utilization of major forest products.
.40 General.
.41 Logging; logging engineering.
.410 General.
.411 Log making.
.4111 Felling.
.4112 Limbing.
.4113 Bucking.
.412 Transportation of logs.
.4121 Animal.
.41211 Ground skidding, snaking, and bunching.
.41212 Wheeling.
.41213 Trucking.
.41214 Sled hauling.
.41215 Trail chuting and trail sliding.
.4122 Steam, electricity, or gas.
.41221 Power skidding and aerial tramways.
.41222 Logging railroads.
.41223 Tractors.
.4123 Water.
.41231 Rafting.
.41232 Driving.
.41233 Fluming and sluicing.
.41234 Barging.
.4124 Gravity chutes and timber slides.
.4125 Hand logging.
.413 Logging equipment and depreciation.
.414 Log grades.
.415 Logging costs.
.416 Logging administration.
.417 Camp management.
.4171 Camp equipment.
.4172 Commissary and dietary.
.4173 Camp sanitation.
.4174 First aid and medical data.
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.419 Miscellaneous.
.42 Lumber manufacture.
.420 General.
.421 Manufacturing plant.
.4211 Log storage.
.42111 Water storage.
.42112 Land storage.
.4212 Sawmill equipment.
.4213 Conveyor system.
.4214 Power plant.
.4215 Yards.
.4216 Dry sheds.
.4217 Dry kilns.
.422 Milling.
.4221 Sawing.
.4222 Resawing.
.4223 Edging.
.4224 Trimming
.4225 Piling and stacking.

.4 Lumbering—Continued.
  .42 Lumber manufacture—Continued.
    .423 Remanufacture of lumber.
    .424 Other sawmill products; milling by-products.
      .4241 Sash and doors.
      .4242 Lath.
      .4243 Shingles.
      .4244 Flooring.
      .4245 Sawdust.
      .4246 Wood fuel.
    .425 Disposal of mill refuse.
    .426 Lumber grades and inspection.
    .427 Manufacturing administration.
    .429 Miscellaneous.
  .43 Special products (principally rough wood products, in part from sawmills).
    .430 General.
    .431 Poles.
    .432 Piling.
    .433 Logs.
    .434 Crossties.
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    .436 Pulp wood.
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    .438 Shakes.
    .439 Miscellaneous.
  .44 Wood-using industries; uses of woods. (For pulp and paper and wood distillation see also .522 and .523.)
    .440 General.
    .441 Box and crate.
    .442 Cooperage.
    .443 Furniture.
    .444 Vehicle and implement.
    .445 Veneer, plywood, and glue.
    .446 Ship and boat building.
    .447 Shingle.
    .448 Airplane.
    .449 Miscellaneous (alphabetically by industries).
  .45 Marketing of products.
    .450 General.
    .451 Methods of selling.
    .452 Transportation; freight rates.
    .453 Distribution and markets.
    .454 Shipping weights.
    .459 Miscellaneous.
  .46 Lumbering accounting.
    .460 General.
    .461 Milling costs.
    .462 Selling costs.
    .463 Lumber prices.
    .469 Miscellaneous.
  .47 Timber and lumber-trade associations.
  .49 Miscellaneous.
.5 Forest technology.
  .50 General.
  .51 Wood technology.
    .510 General.
    .511 Timber physics.
      .5111 Wood structure and identification.
      .5112 Physical properties of wood.
      .5113 Mechanical properties; timber mechanics; timber testing.
    .512 Wood chemistry.
    .513 Conditioning of wood.
      .5131 Air seasoning.
      .5132 Kiln drying.

.5 Forest technology—Continued.
  .51 Wood technology—Continued.
    .514 Wood preservation.
      .5141 Preservatives.
      .5142 Methods and costs.
      .5143 Treating plants and apparatus.
      .5144 Fireproofing.
    .515 Fuel value of wood.
    .516 Wood substitutes.
    .519 Properties and uses of individual woods, foreign and domestic (by general and species).
  .52 Forest by-products; derived products.
    .520 General.
    .521 Naval stores; turpentine orcharding.
      .5211 Distillation of crude turpentine.
      .5212 Methods and costs.
      .5213 Possibilities of various species.
      .5214 Effect on timber.
      .5215 Markets.
    .522 Wood pulp and paper.
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    .524 Tanning materials.
    .525 Sugar.
    .526 Rubber and gums.
    .527 Dyestuffs.
    .528 Cork.
    .529 Miscellaneous.
  .59 Miscellaneous.
.6 Forest engineering.
  .60 General.
  .61 Surveying.
    .610 General.
    .611 Land surveying.
    .612 Topographic surveying.
    .619 Miscellaneous.
  .62 Mapping.
    .620 General.
    .621 Airplane mapping.
    .629 Miscellaneous.
  .63 Construction engineering; forest improvements.
    .630 General.
    .631 Roads.
    .632 Trails.
    .633 Bridges.
    .634 Buildings.
    .635 Fences.
    .636 Telephones and telephone lines.
    .637 Heliographs.
    .638 Lookout towers and special protective works.
    .639 Miscellaneous.
  .64 Hydraulic engineering (including reservoirs, dams, and conduits.)
    .640 General.
    .641 Irrigation.
    .642 Domestic water development.
    .649 Miscellaneous.
  .65 Hydroelectrical engineering.
  .69 Miscellaneous.
.7 Forest management.
  .70 General.
    .701 Determining the cut in the woodland.
    .702 Group selection.
    .703 "Cut and try" method.
  .71 Forest mensuration.
    .710 General.

.7 Forest management—Continued.
.71 Forest mensuration—Continued.
.711 Measurement of logs.
.7111 Board measure; log rules; scaling.
.7112 Cubic measure.
.712 Measurement of lumber.
.713 Measurement of other forest products.
.714 Measurement of felled trees.
.715 Measurement of standing trees.
.7151 Diameter.
.7152 Height.
.7153 Volume tables (alphabetically by species).
.7154 Taper tables (alphabetically by species).
.7155 Form factors (alphabetically by species).
.716 Determination of contents of stands.
.7161 Measurement of all trees.
.7162 Use of sample trees.
.7163 Use of sample plots.
.7164 Ocular estimation.
.717 Growth of timber.
.7171 Determination of age.
.7172 Diameter growth.
.7173 Height growth.
.7174 Volume growth or increment.
.7175 Growth of stands and yield.
.71751 Yield tables.
.71752 Permanent sample plots.
.719 Miscellaneous.
.72 Forest finance.
.720 General.
.721 Forest valuation; determination of forest values.
.7211 Economic and mathematical principles.
.7212 Investments and costs in forest production
.7213 Valuation of forest soil; land values.
.7214 Valuation of growing stock or timber.
.7215 Valuation of entire forests.
.7216 Stumpage values and appraisals.
.7217 Appraisal of damages.
.722 Forest statics; comparison of forest values.
.7221 Determination of profits in forestry.
.7222 Determination of forest per cent.
.7223 Financial test of methods of treatment.
.7224 Comparison of forest with agricultural values.
.723 Timber risks and insurance.
.724 Timber bonds.
.725 Forest taxation.
.729 Miscellaneous.
.73 Forest organization; forest regulation.
.730 General.
.731 Fundamental premises and principles.
.7311 The increment.
.7312 The rotation.
.7313 The cutting cycle.
.7314 The normal forest.
.732 Forest working plans.
.7321 Forest survey; timber survey; forest reconnaissance; collection of data.
.7322 Determination of methods of treatment.
.7323 Regulation of yield; determination of felling budget.
.7324 Control and revision of working plans; working-plan control.
.7325 Forest working plans for special areas.
.739 Miscellaneous.

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.7 Forest management—Continued.
.74 Forest administration.
.740 General.
.741 Personnel and organization of forest staff.
.7411 Federal.
.7412 State.
.7413 Municipal.
.7414 Private.
.742 Forest business practice, forest accounting.
.7421 Federal.
.7422 State.
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.7424 Private.
.743 Forest equipment. (Includes all general equipment; for special technical equipment see specific captions.)
.749 Miscellaneous.
.75 Farm and woodland forestry; wood fuel reserves.
.79 Miscellaneous.
.8 Forest economics. (For forest statistics see individual topics on which statistics are desired.)
.80 General.
.81 Forest influences.
.810 General.
.811 Climate.
.812 Soil.
.813 Water resources and stream flow.
.814 Erosion.
.815 Avalanches.
.816 Public health.
.817 Ethics and morals.
.818 Forest æsthetics.
.8181 Forest parks.
.8182 Shade trees and city parks.
.8183 Shade-tree pests and diseases.
.8184 Shade-tree care; tree surgery.
.819 Miscellaneous.
.82 Lumber and timber economics.
.820 General.
.821 Timber supply.
.822 Production.
,823 Consumption; demand for forest products.
.824 Lumber trade.
.829 Miscellaneous.
.83 Industrial relation of forests.
.830 General.
.831 Woodworking.
.832 Agriculture.
.833 Railroading.
.834 Mining.
.839 Miscellaneous.
.84 Forest resources, conditions, and production.
.840 General.
.841 United States (alphabetically by States).
.842 Foreign countries (alphabetically by countries).
.849 Miscellaneous.
.85 Tariff on lumber and forest products.
.850 General.
.851 Exports.
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.859 Miscellaneous.
.86 Forest legislation (alphabetically by countries and States). (For game and fish legislation see .8712.)
.860 General.
.861 Fire.
.862 Tax.
.869 Miscellaneous.

.8 Forest economics—Continued.
.87 Forest policy.
.870 General.
.871 National-forest policy.
.8711 Utility of national forests.
87111 Timber-production and silvicultural policy.
.87112 Watershed protection.
.87113 Water-power development.
.87114 Public use and recreational purposes.
.87115 Use of agricultural lands.
.87116 Use of grazing lands and grazing policy.
.87117 Use of mineral lands.
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.8714 Development of science by investigation and research.
.8715 Cooperation and demonstration.
.8716 Regulation of privately owned forests.
.872 State or provincial forest policies (alphabetically by States and Provinces).
.8721 Land policy.
.8722 Silvicultural policy.
.8723 Grazing policy.
.8724 Educational policy.
.8725 Cooperation and demonstration.
.8726 Regulation of privately owned forests.
.873 Municipal forest policies (alphabetically by States or Provinces and municipalities).
.874 Private forest policies (alphabetically by States or Provinces and individuals or corporations).
.875 Foreign forest policies (alphabetically by countries).
.879 Miscellaneous.
.89 Miscellaneous.
.9 Miscellaneous.
.90 General.
.91 Grazing.
.910 General.
.911 Range and pasture plants.
.9111 Identification.
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.9113 Forage value.
.9114 Poisonous plants.
.9115 Ecology.
.912 Range management.
.9121 Plans.
.9122 Utilization and maintenance.
.9123 Improvement.
.9124 Development.
.913 Range livestock industry.
.9131 Cattle and horses.
.9132 Sheep and goats.
.9133 Livestock management.
.914 Grazing influences.
.9141 Forest growth and reproduction.
.9142 Forest fires.
.9143 Watershed protection.
.9144 Wild life.
.9145 Recreational use.
.915 Range and livestock economics.
.919 Miscellaneous.

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.9 Miscellaneous—Continued.
  .92 Game and fish. (See also .8712.)
    .920 General.
    .921 Studies of species (alphabetically by species).
    .922 Game and fish administration.
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      .9222 Cooperation. (See also .8715 and .8725.)
      .9223 Refuges.
    .923 Game and fish management.
      .9231 Game census.
      .9232 Natural enemies.
      .9233 Regulation of kill.
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      .9235 Restocking.
    .929 Miscellaneous.
  .93 Water-power development. (See also .65.)
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    .951 Camping and outdoor life.
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FORESTRY

SILVICULTURE

General

Kinds of Trees to be Encouraged.—The trees should be thrifty, of the most desirable species, and properly spaced. To determine the relative value of the various species, one must consider the products, the character of the soil, and the general climatic conditions where they are being grown. Ordinarily native trees should be encouraged, and especially those upon which local industries are dependent. For example, in the New England States and other portions of the Northeast white pine is worth encouraging. In localities where veneer basket logs are made red gum, tulip poplar, and basswood are in demand, but other species are often taken.

Trees should be considered with regard to their natural resistance to enemies. For example, chestnut is a valuable tree and would be worth encouraging, except that the blight has practically sealed its doom. White pine must be handled with regard to its susceptibility to the blister rust, and the necessary protective measures should be carried out before encouraging it.

When to Cut.—Cutting may be done at any season of the year. Farmers ordinarily find it most satisfactory, however, to cut during the time when the pressure of farm work is least, normally in the winter season. Winter cutting has certain advantages, chief among them being that insects and fungi are least active at this period; there is less tendency for the logs to dry rapidly and check; and in those species which are capable of so doing sprouting is most successful.

Aids for Determining Cutting Method.—All trees reproduce themselves by seeds, but some of them have the added ability to reproduce themselves by sprouts and cuttings.

The wind aids in scattering the light seeds of trees like maple, ash, elm, and most of the pines, spruces, and firs. It is possible for the wind to scatter light seeds for a distance of ten times the height of the parent trees, but ordinarily it is not safe to rely on their being scattered farther than three times the height of the trees.

The heavy seeds of trees like the oaks, hickories, and walnut can not be carried by the wind. If the parent trees are growing on a slope, the nuts may roll or be washed for a short distance. Squirrels and other animals also aid in scattering them.

Many hardwood or broad-leafed trees reproduce themselves by sprouts from the stumps and roots. Some of the yellow pines and the California redwood sprout from the stumps, but the redwood is the only coniferous or needle-leafed tree in which this tendency is strong enough to be of value to the lumber industry.

Trees sprout best if they are cut during the winter when the trees are dormant. Sprouts from summer-cut trees are usually weak and in danger of being killed by early frosts.

When trees are cut to produce sprouts the stumps should be as low as possible. The surface should be smooth and slanting to insure good drainage.

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Sprouts grow more rapidly than seedlings, but they mature earlier and do not attain as large size. Because of the dead stump at the base they develop butt rot at a comparatively early age.

Sprouts from the stumps of sprout trees are shorter lived and grow less rapidly than sprouts from the stumps of seedling trees. Accordingly, seedling trees should be encouraged among a forest of sprouts.

All trees require direct sunlight for their best growth, but they will stand considerable shade during their youth.

Some trees demand more sunlight than others. The pines are particularly light-demanding, but maple, beech, hemlock, and spruce can grow under a considerable amount of shade.

Light-demanding trees must be released from overtopping trees which shade them, or they will not prosper and will finally die.

Maturity.—The age at which a tree reaches natural maturity depends upon the species, the site, and conditions of growth. A mature tree usually reaches a comparatively large size. The bark is rough and the crown flat, with gnarly limbs. Trees may continue to live long after they have attained maturity, but decay often follows. Growth is slow, as shown by narrow growth rings. Trees are financially mature when they are large enough to produce the material that is desired. For example, a stand of spruce being grown for pulp wood, or of pine for box boards, is mature when the stand is 30 to 50 years old. The same trees may not be physically mature until they are 100 or perhaps 300 years old. Were they allowed to reach such an age they would long since have passed their economic maturity, and the overhead costs of interest and taxes would probably have eaten up any profits. Good management requires that trees be cut when they are financially mature.

Silvicultural Systems

Methods of Cutting.—Most farms need a supply of firewood, fencing, and similar material every year. Clear cutting should therefore be avoided, except in small portions of the woods and where the character of the trees demands this kind of treatment.

A forest of shallow-rooted trees usually has to be clear cut, because when single trees are left standing they are liable to be wind thrown. Under some conditions clear cutting may have to be followed by planting or seeding with desirable trees in order to provide for the next timber crop.

Cuttings to Obtain Reproduction.—When the trees are big enough to provide saw logs, ties, pulp wood, and other more valuable products, the method of cutting must be determined.

In a pine forest it is best to make a heavy thinning about five years before the final cutting. The removal of about one-half of the trees will let in sunlight and permit the pine seed to germinate. After young growth is started the rest of the mature trees can be cut.

With shade-enduring trees like spruce, fir, and hardwoods, or in mixed growth, each acre may contain trees of many different ages. In such a woods the individual trees may be selected for cutting as they mature, leaving the surrounding young trees to keep on growing.

Selection Method.—Some of the more definitely worked-out methods of handling woodlands are described as follows:

The selection method takes out the trees singly or in small groups. Unless intelligently done, it is liable to result in taking out the best trees and leaving the poorer ones to reproduce themselves.

The group-selection method consists in taking out small groups of merchantable trees. The small cut-over area is protected by surrounding high growth, and reproduction by those trees which are particularly light-demanding is encouraged. Thinning within the cut-over area may be necessary after good reproduction is established. This method of cutting seldom takes more than one-fourth of the stand.

Shelter-Wood Method.—This method aims to obtain natural reproduction by means of a series of two or more cuttings. This admits an increasing supply of light to the seedlings which grow under the protection of the remaining seed trees. In theory this method requires a series of four cuttings.

(1) *Preparatory cutting* removes the dead, dying, and defective trees, so that seed production on the part of the desirable trees is encouraged. This is similar to an improvement cutting.

(2) *Seed cutting* follows a few years after. This opens up the stand and lets in the light which the expected seedlings will require.

(3) *Removal cuttings* follow in approximately 10 years. The aim is to remove the mature stand in such a way as not to interfere with the development of the young trees.

(4) *Final cutting* is the last of the removal cuttings, and takes all that remains of the old stand.

There are many modifications of this method to suit the conditions of the tract in hand. Accordingly, the period of operation may vary from a few years to a comparatively long time.

Intermediate Cuttings

Improvement Cuttings.—Farm woodlands are usually so neglected and misused that an improvement cutting is necessary as the first step in getting the timber crop in good condition. The object of such a cutting is to cut the slow-growing, mature, and overmature trees and replace them with young, rapidly growing ones. One way of doing this is to decide which are the best trees to save for further growth, and then mark the remainder for cutting. Local conditions will modify the application of such a rule. For example, if certain specific products are desired the tendency will be to cut those trees that will furnish them. The owner should save for future cuttings as many as possible of the firm, fast-growing trees which will develop into saw logs, veneer logs, or other valuable material.

Avoid large openings, but plan to return for further cuttings in about 10 years.

Cut crooked, misformed, injured, and overshaded trees. This includes those trees which have no chance for development and those which give indication of decaying in 10 years or less. Trees with open fire scars, wounds, or fruiting bodies of decay-producing fungi probably have started to decay and should be cut.

Cut mature and overmature trees as rapidly as they can be used or sold to advantage. Trees which have reached maturity do not produce wood vigorously and therefore are not profitable. All trees that are removed

will make room for young, vigorous-growing ones that will produce valuable forest products.

Cut dead, dying, or weakened trees.

Leave thrifty, vigorous trees of the more valuable kinds.

Cleanings.—While the stand is still very young, say 8 to 15 feet high, it often pays to "weed" it. Cut out the poorer species, crooked, forked, or crowded trees with a brush hook or light ax, leaving straight trees of good kinds, like ash, basswood, tulip poplar, sugar maple, oak, pine, and spruce. The object is to give each tree enough space to be comfortable without crowding the crowns, but there should not be so much space as to allow the tree to spread out to branches instead of to grow tall, straight trunks. If a stand is not "weeded" the worthless trees will use up the sunlight, moisture, and soil fertility needed by the good ones.

After a few years, as the young trees begin to crowd again, they should be further thinned. Always take out the cull trees and leave the good ones. Do not open up the stand too much. The crowns of the good trees should barely touch one another. Keep taking out the trees that are overtopped, as well as those that are crooked, knotty, rotten, or otherwise worthless. In a fair-sized piece of woodland this work can be carried on every year. Wood needed on the farm, such as posts, poles, stakes, and fuel, may well be taken from these poor trees.

Thinnings.—Stands of "second growth" often come in after all the original timber is cut. Frequently they are growing on land cleared for agriculture but afterwards abandoned. Often the woods consist of sprouts and seedlings of many kinds, the valuable mixed with the inferior. When the stands are not more than 40 or 50 years old they can usually be improved by thinning.

Remove the crowded and suppressed trees of the less valuable kinds, leaving the outstanding trees of the better species for further growth. From one-fourth to one-third of the trees in a crowded stand may often be removed with advantage to those that remain.

The products may be cordwood, fence posts, and small poles, and occasionally some mine timbers and ties. Ordinarily the profits are not great, but usually the returns will more than pay for the cost of the work. The real benefit is that the trees which have been released produce wood several times faster than those in unthinned, crowded stands.

Rules for Thinning a Woodland.—The object is to get sound, healthy trees of best species, spaced as uniformly as possible under existing natural conditions.

(1) Thin only when products can be utilized or sold.

(2) Thin trees which interfere with others.

- (*a*) Remove those making the least growth, generally indicated by small, unhealthy crowns.
- (*b*) Remove those which are most unhealthy, crooked, damaged, forked, or leaning.
- (*c*) Remove least valuable species, such as pitch pine and poplar.

(3) Thin undesirable trees which do not interfere with others.

- (*a*) Remove dead and dying trees—
  - To utilize them before further deterioration.
  - To prevent spread of tree diseases.
  - To prevent damage by falling.
- (*b*) Remove stunted trees.
- (*c*) Remove inferior species and crooked or leaning trees.

Rules for Cutting.—(1) Cut all stumps as low as possible.
(2) Cut stumps so as to shed water.
(3) Utilize each tree as far as possible into top.
(4) Scatter the branches about as evenly as practicable.

Planting

Kinds and Classes of Plant Material.—The kinds of trees to choose for planting depend upon the purpose for which they are to be used, the available kinds, and the character of the land to be planted. Except for experimental purposes, the selection should always be limited to those trees which are native to the region, or to those which have been proved successful in the region, and of local value.

Forest planting can be accomplished most satisfactorily and cheaply by the use of comparatively young, vigorous stock. The ages will vary with the species of trees, usually from 1 to 3 years.

Conifers.—Six to fourteen inches high. In the Northern States the stock will be 2 or 3 year old seedlings, or 3 or 4 year old transplants. In the Southern States 1 or 2 year old seedlings. (The root system of seedlings is less well developed than that of transplants, and suffers under adverse conditions.)

Broad-leaved deciduous trees.—Six to eighteen inches high, some species as tall as 24 inches. Usually 1 year old. Slower-growing trees, 2 years.

Source of stock.—A number of commercial nurseries furnish trees at prices suitable for economic forest planting. Direct inquiry should be made of the nurseries to determine these prices. Lists are available from your State forester or the forester, Forest Service, Washington, D. C.

Stock for forest planting within the State can be procured at a nominal price (including cost of packing and shipping) from a few States,[1] namely:

California.—State board of forestry, Sacramento, Calif.[2]

Colorado.—State forester, Fort Collins, Colo.[2]

Indiana.—Department of conservation, Indianapolis, Ind.[2]

Idaho.—Agricultural experiment station, Moscow, Idaho.[2]

Iowa.—Iowa State College of Agriculture, Ames, Iowa.[2]

Kansas.—State forest nurseries, Hays, Kans.[2]

Maine.—State forest nursery, Orono, Me.

Maryland.—State department of forestry, Baltimore, Md.

Massachusetts.—Department of conservation, Boston, Mass.

Michigan.—Department of conservation, Lansing, Mich.; Michigan State College, East Lansing, Mich.

Minnesota.—Forest experiment station, Cloquet, Minn.[2]

New Hampshire.—State forestry department, Concord, N. H.

New Jersey.—State forester, Trenton, N. J.

New York.—Conservation commission, Albany, N. Y.

Ohio.—Department of forestry, Wooster, Ohio.

Pennsylvania.—Department of forests and waters, Harrisburg, Pa.

North Dakota.—Dry-land experiment station, Mandan, N. Dak. Stock is available in limited numbers to land-

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[1] List prepared Jan. 1, 1925; subject to change.
[2] Stock available in limited quantities for demonstration or experimental purposes.

owners in Montana, North Dakota, South Dakota, and Wyoming.[2]

Vermont.—Commission of Forestry, Montpelier, Vt.

Virginia.—State forester, Charlottesville, Va.

Washington.—State College of Washington, Pullman, Wash.[2]

Wisconsin.—State conservation commission, Madison, Wis.

Wild seedlings can be dug up and transplanted, but they are usually less desirable than nursery-grown stock. Small seedlings are best. Dig them carefully, so as to include as much root as possible. Prune long, straggling roots.

Season of planting.—The best time to plant is in the early spring, before the buds swell. In Northern States trees can be set out as soon as the frost is out of the ground and the soil easily worked.

Fall planting can be successfully carried out on protected locations, and in lighter soils that will not heave, provided there is abundant soil moisture at the time and no severe drought following.

Methods.—Plants should be heeled in as soon as received. If the stock is to remain heeled in for several days, open the bundles and spread the plants along the trench. Never allow the roots to dry or to be exposed to direct sunlight. Such exposure can be largely avoided if the roots are "puddled" in thin mud. Avoid doubling the roots back upon themselves when setting them in the ground.

Hole method of planting.—Two men work together as a crew, one man with a mattock or heavy hoe, the other with a pail of trees. The first man digs a hole wide enough and deep enough for the roots to be placed naturally. The second man sets the trees in the hole at the same depth as they originally grew. As the hole is filled pack the fine earth firmly about the roots, and finally press it down with the foot. Do not replace sod. Two men can plant from 800 to 1,000 trees a day.

Slit method.—Remove any competing surface vegetation. A mattock or a long-handled shovel is sunk into the ground, and the handle pressed back to one side. This opens a hole at the end and edge of the blade. Insert the tree roots, remove the tool, and firm the soil with the heel. One man can plant 400 to 500 trees a day.

Dibbling.—This method is only satisfactory for small stock and in ground that is not stony. A dibble is pushed into the ground and a tree inserted in the hole. While the tree is held upright, use the dibble to firm the soil around the roots and stem. In loose soils one man can plant 1,000 to 2,000 trees a day.

Sites and Effect of Cover.—The vegetation on and immediately around the place where the tree is to be set should be removed. On level or slightly rolling areas and on sandy lands it is practicable to remove the grass and other competing vegetation by plowing shallow furrows. Ordinarily the tree should be set in the bottom of the furrow. On wet sites the trees can be set on top of the furrow. The furrow top should be thoroughly firmed when trees are set to prevent the roots from drying.

Spacing of Planted Trees.—The spacing generally recommended is 6 by 6 feet. This assures an early covering of the land with trees at a nominal investment. Within a few years the crowns begin to shade the ground

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[2] Stock available in limited quantities for demonstration or experimental purposes.

establishing conditions comparable to those in a natural forest. Continued growth shades the side branches, resulting in the death and natural pruning of the lower limbs. This produces trees with straight trunks free from knots. Too wide spacing results in limby trees, encouraging weeds and grass within the stand.

Slow-growing trees capable of enduring considerable shade may be planted closely. Rapid-growing trees which demand much sunlight may be planted widely apart—for example, 6 by 8 feet, or 8 by 8 feet.

Planting table

Spacing	Trees to the acre[1]	Spacing	Trees to the acre[1]
Feet	*Number*	*Feet*	*Number*
3 by 3	4,840	7 by 7	890
4 by 4	2,722	8 by 8	680
5 by 5	1,742	9 by 9	538
6 by 6	1,210	10 by 10	436

[1] 43,560 square feet to the acre.

Care and Protection of Plantation.—(1) Keep fire and grazing animals out of planted stands.

(2) Clean out the brush and volunteer trees when they begin to damage or to suppress the planted trees.

(3) Insects and fungous diseases require special attention. Their presence should be reported immediately to the local or State authorities.

(4) Thinnings are seldom necessary until the plantation is 15 to 20 years old. There are exceptions, as in the case of evergreens for Christmas trees, and such rapidly growing species as black locust for posts.

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LUMBERING

Marketing of Products

The following rules should be observed in the marketing of wood-lot products:

(1) Obtain price quotations for wood-lot products from as many consumers as possible (sawmills, wood-using industries, and the like).

(2) Investigate a number of markets, local and those at a distance.

(3) Do not sell the standing timber for a lump sum unless through a careful estimate you have obtained reasonably exact knowledge of the amount. It is usually preferable to sell by log scale, stacked cord, or other unit.

(4) The wood-lot owner is not forced to place his timber on the market regardless of market conditions. Wait for a favorable market. Standing timber does not deteriorate rapidly.

(5) Consider the financial responsibility of the prospective purchaser and thus avoid slow payments, costly collections, and losses.

(6) Protect yourself with a written timber-sale agreement.

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Approximate weights of various wood products

Species	Lumber (per 1,000 board feet)			Logs (per 1,000 board feet log scale, Doyle rule)						Cordwood, bolts, butts, etc. (per cord)	
				12 inches diameter		18 inches diameter		24 inches diameter			
	Air-dry	Green	Rough (classed as 1 inch thick) "shipping dry"	Green	Dry	Green	Dry	Green	Dry	Green	Dry
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Ash, white	3,500	4,000	3,800	11,100	9,700	7,700	6,800	6,600	5,700	4,300	3,800
Aspen (popple)	2,200	3,900	2,250	10,800	6,200	7,600	4,300	6,400	3,700	4,200	2,400
Basswood	2,100	3,400	2,500	9,500	5,900	6,600	4,100	5,600	3,500	3,700	2,300
Beech	3,600	4,600	4,000	12,700	10,100	8,900	7,000	7,500	6,000	5,000	3,900
Birch, yellow	3,700	4,800	4,000	13,200	10,300	9,200	7,200	7,800	6,100	5,100	4,000
Cedar, western red	1,900	2,200	3,000	6,200	5,300	4,300	3,700	3,700	3,100	2,400	2,100
Cherry, black	3,000	3,800	3,800	10,500	8,300	7,300	5,800	6,200	4,900	4,100	3,200
Chestnut	2,500	4,600	2,800	12,600	7,000	8,800	4,900	7,500	4,100	4,900	2,700
Cottonwood	2,200	3,600	2,800	10,700	6,300	7,500	4,400	6,300	3,700	4,200	2,500
Cypress, southern	2,800	4,200	3,000	11,800	7,800	8,200	5,500	7,000	4,600	4,600	3,100
Elm:											
White	2,900	4,000	3,100	11,300	7,800	7,900	5,500	6,700	4,600	4,400	3,100
Slippery	3,300	4,600	4,000	12,600	9,200	8,800	6,400	7,400	5,500	4,900	3,600

Approximate weights of various wood products—Continued

Species	Lumber (per 1,000 board feet)			Logs (per 1,000 board feet log scale, Doyle rule)						Cordwood, bolts, butts, etc. (per cord)	
	Air-dry	Green	Rough (classed as 1 inch thick) "shipping dry"	12 inches diameter		18 inches diameter		24 inches diameter			
				Green	Dry	Green	Dry	Green	Dry	Green	Dry
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Fir:											
Balsam	2,100	3,700	--------	10,400	5,800	7,200	4,000	6,100	3,400	4,000	2,200
Douglas	2,800	3,100	3,300	8,700	7,700	6,100	5,400	5,200	4,600	3,400	3,000
Gum:											
Black	3,000	3,700	2,800	10,400	8,300	7,200	5,800	6,100	4,900	4,000	3,200
Red (sweet)	2,800	3,900	3,300	10,600	8,100	7,400	5,600	6,300	4,800	4,200	3,100
Hackberry	3,500	4,400	3,200	11,300	8,900	7,900	6,200	6,700	5,200	4,400	3,500
Hemlock, eastern	2,400	4,000	2,500	11,200	6,600	7,800	4,600	6,600	3,900	4,400	2,600
Hickory	4,300	5,200	4,500	14,700	11,900	10,300	8,300	8,700	7,000	5,700	4,600
Juniper, western	--------	--------	--------	--------	--------	--------	--------	--------	--------	4,000	3,200
Locust, black	4,100	4,800	--------	13,400	11,300	9,300	7,900	7,900	6,700	5,200	4,400
Maple:											
Sugar	3,600	4,700	3,900	12,900	10,000	9,000	7,000	7,600	5,900	5,000	3,900
Red	3,000	4,300	3,300	11,900	8,200	8,300	5,700	7,100	4,900	4,700	3,200
Silver	2,800	3,800	3,300	10,500	7,800	7,300	5,400	6,200	4,600	4,100	3,000

Oak:											
Red	3,600	5,400	4,000	14,800	10,400	10,300	7,300	8,800	6,200	5,800	3,900
White	4,000	5,200	4,000	14,400	10,900	10,000	7,600	8,500	6,500	5,600	4,300
Pine:											
Jack	2,500	4,200		11,500	6,900	8,000	4,800	6,800	4,100	4,500	2,700
Loblolly	3,200	4,500		12,400	9,000	8,700	6,300	7,400	5,300	4,300	3,200
Long-leaf	3,500	4,000	3,500	11,100	9,700	7,700	6,800	6,500	5,700	4,000	3,500
Norway (red)	2,800	3,500		9,700	7,800	6,800	5,500	5,700	4,600	3,500	2,800
Piñon										3,900	3,000
Pitch	3,000	4,500		12,400	8,300	8,700	5,800	7,400	4,900	4,900	3,200
Short-leaf	3,000	3,700	3,300	10,400	8,300	7,200	5,800	6,100	4,900	4,000	3,200
Slash	3,700	4,400		12,200	10,400	8,500	7,200	7,200	6,100	4,800	4,000
Sugar	2,200	4,200		11,500	6,200	8,000	4,300	6,800	3,700	4,500	2,400
Western yellow	2,300	4,100	2,600	11,300	6,500	7,900	4,500	6,700	3,800	4,400	2,500
White	2,200	3,200	2,400	9,000	6,200	6,300	4,300	5,300	3,700	3,500	2,700
Poplar, yellow (tulip)	2,400	3,200	2,800	8,800	6,500	6,100	4,500	5,200	3,800	3,400	2,500
Redwood	2,100	3,200	2,100	8,900	5,900	6,200	4,100	5,200	3,500	3,500	2,300
Spruce, eastern	2,400	2,800		7,700	6,600	5,400	4,600	4,600	3,900	3,000	2,600
Sycamore	3,000	4,300	3,000	12,000	8,300	8,400	5,800	7,100	4,900	4,700	3,200
Tupelo gum (bay poplar)	3,000	5,500	2,800	15,200	8,500	10,600	5,900	9,000	5,000	5,900	3,300
Walnut, black	3,000	4,300	3,800	11,900	8,200	8,300	5,700	7,100	4,900	4,700	3,200
Willow	2,100	4,300	2,800	11,800	6,000	8,200	4,200	7,000	3,500	4,600	2,300

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FOREST MANAGEMENT

General

Determining the Cut in the Woodland.—To assure a sustained yield from the woodland, have some plan for determining the amount which can be safely removed. This should be based upon the annual growth. Assuming that the woodland will be protected against fire and excessive grazing and that the best trees will be encouraged by thinnings and improvement cuttings, it is safe to say that the annual growth of most farm woodlands can be increased. This is one of many reasons why it is undesirable to attempt to establish a fixed and permanent annual crop for more than a few years at a time.

Group Selection.—This method of cutting is particularly adapted to farm woodland conditions. Take as an example 40 acres covered with a normal stand of trees which may be cut into saw logs when they are 80 years old. In all probability the woods will include trees of all ages. Each year some will reach maturity. Plan to cut off the merchantable trees as rapidly as they attain the age of 80 years. Actually the owner will not reckon in terms of years, but rather according to the size to which he has decided to cut. Experience has shown that the entire area may be cut over in 40 years, or just half the number of years at which the trees reach maturity.

The actual work may take the form of an annual cutting of four groups of about one-fourth acre each. If the owner feels that this is too small to bother with, he may cut the mature timber from 5 acres, or from 20 one-fourth-acre plots, and then wait five years before making another large cutting. In any case the series of cuttings will be planned to carry over a period of 40 years.

Such a plan presents some difficulties when applied for the first time to the average farm woods. It may have to be preceded by an improvement cutting to get rid of the large, overmature trees. If it is carried through the full 40 years, it should result in a fully stocked forest containing trees of different ages up to 80 years.

" Cut and Try " Method.—Another way to determine the cut from a woodland is to assume an arbitrary figure as the probable annual growth per acre and make the cuttings on that basis. Subsequent changes in this amount may be made if the woods give evidence of having been undercut or overcut.

For example, on the basis of the owner's experience or observations, it may be assumed that the woods will produce half a cord of wood an acre each year. (A cord is a pile 4 by 4 by 8 feet.) One hundred acres could be expected to produce 50 cords per year. The cuttings may be made on the basis either of a full crop each year or of small crops of perhaps 15 cords of thinnings for firewood material during a period of four years, and a big crop in the fifth year. During the four years of small cuttings a surplus of 140 cords would have accumulated, which, added to the growth of 50 cords for the fifth year, would give a possible crop of 190 cords. If the trees are of saw-log size it is usually safe to assume that a cord of logs can be sawed into 500 board feet of lumber. After 10 years of this method the owner can determine from his observation whether the woods are being too heavily cut or if the growth is exceeding the crop and vary his cutting accordingly.

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Doyle log rule

Diameter of log, small end, inside bark (inches)	Length of log in feet: 8	10	12	14	16	18
	Contents of log in board feet					
6	2	2	3	3	4	4
7	4	5	7	8	9	10
8	8	10	12	14	16	18
9	12	16	19	22	25	28
10	18	22	27	31	36	40
11	24	31	37	43	49	55
12	32	40	48	56	64	72
13	40	51	61	71	81	91
14	50	62	75	87	100	112
15	60	76	91	106	121	136
16	72	90	108	126	144	162
17	84	106	127	148	169	190
18	98	122	147	171	196	220
19	112	141	169	197	225	253
20	128	160	192	224	256	288
21	144	181	217	253	289	325
22	162	202	243	283	324	364
23	180	226	271	316	361	406
24	200	250	300	350	400	450
25	220	276	331	386	441	496
26	242	302	363	423	484	544
27	264	331	397	463	529	595
28	288	360	432	504	576	648
29	312	391	469	547	625	702
30	338	422	507	591	676	760
31	364	456	547	638	729	820
32	392	490	588	686	784	882
33	420	526	631	736	841	946
34	450	562	675	787	900	1,012
35	480	601	721	841	961	1,081
36	512	640	768	896	1,024	1,152
37	544	681	817	953	1,089	1,225
38	578	722	867	1,011	1,156	1,300
39	612	766	919	1,072	1,225	1,378
40	648	810	972	1,134	1,296	1,458

To find the number of board feet in a log according to Doyle rule, deduct 4 from the diameter (in inches) of the small end and square the remainder. This gives the contents of a 16-foot log in board feet. The number of board feet in logs of other lengths is in proportion to their lengths; for example, an 8-foot log contains half as many board feet as a 16-foot log, and so on.

The above figures were obtained in this manner.

Scribner's log rule

Diameter at top (inches)	Length of log in feet					
	8	10	12	14	16	18
	Contents of log in board feet					
6	4	5	6	7	9	10
7	8	10	12	14	16	18
8	12	15	19	22	25	28
9	18	23	27	32	36	40
10	24	30	37	43	49	55
11	32	40	48	56	64	72
12	40	49	59	69	79	88
13	48	61	73	85	97	109
14	57	72	86	100	114	129
15	71	89	107	125	142	160
16	79	99	119	139	159	178
17	93	116	139	162	185	208
18	106	133	160	187	213	240
19	120	150	180	210	240	270
20	140	175	210	245	280	315
21	152	190	228	266	304	342
22	167	209	251	292	334	376
23	188	235	283	330	377	424
24	202	252	303	353	404	454
25	229	287	344	401	459	516
26	250	313	375	439	500	562
27	274	342	411	479	548	616
28	291	363	436	509	582	654
39	305	381	457	533	609	685
30	328	411	493	575	657	739
31	355	444	532	622	710	799
32	368	460	552	644	736	828
33	392	490	588	686	784	882
34	400	500	600	700	800	900
35	438	547	657	766	876	985
36	462	577	692	807	923	1,038

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International log rule

Diameter at top (inches)	Length in feet						
	8	10	12	14	16	18	20
	Volume in board feet						
6	7	10	13	16	19	23	27
7	12	15	19	24	28	33	39
8	16	21	27	33	39	45	52
9	23	29	36	43	51	59	68
10	29	37	45	54	64	75	86
11	36	46	57	68	80	92	105
12	44	57	70	83	97	111	127
13	52	68	83	100	116	133	151
14	62	80	98	117	136	156	176
15	73	94	114	136	157	180	204
16	84	108	131	156	181	207	233
17	96	123	149	177	205	235	265
18	110	139	169	201	232	265	299
19	123	156	190	225	261	297	335
20	138	174	212	251	290	330	372
21	152	193	234	279	321	366	412
22	168	214	259	307	354	404	453
23	186	235	285	337	388	442	497
24	203	257	311	367	424	481	542
25	222	280	339	402	461	526	590
26	241	305	368	435	501	569	640
27	260	330	399	471	542	615	691
28	281	356	431	507	585	663	745
29	303	383	463	546	629	712	800
30	326	411	497	585	674	765	858
31	349	440	532	627	721	818	918
32	373	470	568	670	770	873	978
33	399	502	605	714	821	932	1,042
34	424	534	644	759	872	991	1,108
35	450	567	684	805	927	1,050	1,176
36	476	600	725	853	981	1,112	1,244

Values calculated to nearest foot by formula.
Adjusted and checked by curves.

Volume Tables

Quantity of material contained in trees of different sizes[1]

Diameter of tree breast high (inches)	Number of trees of each size required to yield—						Tie and pole product per tree	
	1 cord			1,000 feet of lumber				
	Hardwoods			Hardwoods				
	Northern	Southern	Softwoods	Northern[2]	Southern[3]	Softwoods	Number of ties, hardwoods[4]	Lenth of pole, hardwoods[5]
								Feet
2	------	170	------	------	------	------	------	------
3	------	90	------	------	------	------	------	------
4	------	50	------	------	------	------	------	------
5	35	25	------	------	------	------	------	------
6	20	17	------	------	------	------	------	------
7	15	13	20	------	------	------	------	------
8	11	9	13	------	------	25	------	------
9	8	7	10	85	66	20	------	------
10	6	6	8	45	33	15	1	------
11	5	5	7	28	22	10	1	------
12	4	4	6	19	13	8	2	25
13	3.5	3.4	4.5	14	11	7	2	25
14	3.0	3.0	3.7	11	9	6	3.3	30
15	2.5	2.5	3.0	8	7	5	3.3	35
16	2.0	2.2	2.5	7	6	4	------	40
17	1.7	2.0	2.1	6	5	3.1	------	40
18	1.5	1.8	1.9	5	4.5	2.6	------	45
19	1.3	1.5	1.6	4	4.0	2.4	------	45
20	1.2	1.3	1.5	3.5	3.3	2.1	------	45
21	1.0	1.2	1.4	3.1	3.0	1.8	------	50
22	.9	1.1	1.2	2.7	2.7	1.7	------	55
23	.8	1.0	1.1	2.3	2.5	1.6	------	55
24	.7	.9	1.0	2.0	2.2	1.5	------	55

[1] From Bulletin 9, State of New York Conservation Commission (adapted in tie and pole production).

[2] For every thousand feet of lumber about two-thirds of a cord of wood can also be cut from the tops.

[3] For every thousand feet of lumber about three-quarters of a cord of wood can also be cut from the tops.

[4] For every 10 ties about 1 cord of wood can also be cut from the tops.

[5] For every 10 poles about 1 cord of wood may also be cut from the tops.

NOTE.—Softwoods taken to 4 inches top diameter. Northern hardwoods, beech, birch, and maple, to 4 inches top diameter. Southern hardwoods, chestnut, oak, hickory, basswood, ash, etc., to 3 inches top diameter.

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Estimating Standing Timber

[Without volume tables]

Unless the tract is large, it is desirable that every tree be estimated separately. The procedure is as follows. A notebook or sheet of paper should be ruled off in squares of a convenient size, somewhat as shown in the sample diagram below:

Species	Butt log			Second log			Third log			Total scale
	Length	Diameter	Scale	Length	Diameter	Scale	Length	Diameter	Scale	
	Ft.	*Ins.*	*Bd.ft.*	*Ft.*	*Ins.*	*Bd.ft.*	*Ft.*	*Ins.*	*Bd.ft.*	*Bd.ft.*
White oak	16	16		16	14		16	11		
Red oak	12	10		12	8					
Sugar maple	14	15		12	12					
Beech	16	18		16	16		14	13		
(Etc.)										

The estimator looks over each tree and makes an estimate of the number of logs that can be cut out of it. Suppose the first tree is a white oak which forks at about 50 feet from the ground. Above that point the branches are too small or too crooked to be used for saw logs. If the stump is allowed for, the merchantable length of the tree is 48 feet, or three 16-foot logs. By looking at the tree carefully the estimator decides that the diameter, inside the bark, at the top of the first 16-foot log is 16 inches. Sixteen feet farther up the diameter appears to be 2 inches less, while at the top of the third log the diameter is 11 inches. These figures are entered in the proper spaces as shown in the diagram.

When each tree is estimated it should be marked in some way so that there will be no chance of its being measured again. A piece of chalk may be used, or a small blaze may be made with a hatchet. This procedure is continued, the trees being taken as they come, but only those estimated which are big enough to be merchantable.

Later on the number of board feet in each of the three logs can be determined with the aid of a log rule and the total board-foot contents of the tree found by addition of the results.

It is advisable to estimate the trees on a strip of fairly uniform width, continuing across the tract until the other side is reached. On the return trip the estimator can follow the outside line of the previous course.

This insures getting all the trees without covering unnecessary ground. The width of the strip on which the timber is estimated will depend upon the convenience of the operator. Under average conditions 50 feet is good.

This method can also be used for estimating posts or poles, or even cordwood. If posts are to be estimated the species or kind of wood, the length, and the top diameter of each should be recorded. If the facts are put down in this form the value of all the posts or of any particular class may be easily calculated.

This same method can be adapted to larger tracts by the taking of a sufficient number of strips through the woods so that a representative sample of the entire area is obtained.

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Approximate time required to produce different wood crops [1]

Species	Locality	Average diameter 6 inches (post)	Average diameter 8 inches (handles, extract, pulp, spool, fuel, props)	Average diameter 11 inches (ties)	Average diameter 14 inches (poles and piles)	Average diameter 18 inches (saw timber)
		Years	*Years*	*Years*	*Years*	*Years*
Arborvitæ or Northern white cedar	Minnesota	80 to 100				
Aspen	Maine	25 to 30	30 to 70	50 to 100	60	80
Ash, white	New York	20 to 30	30 to 40	40 to 50	40 to 60	55 to 85
Basswood	Michigan and Wisconsin	35 to 45	45 to 60	65 to 85	80 to 100	100
Beech	Michigan	75 to 90	90	100		200
Birch, paper	Maine		50			
Birch, yellow	New York	60 to 70	85	100	150	180
Cedar, red	Alabama	25 to 50	35 to 60	50 to 70	70 to 80	
Chestnut	East Tennessee	30 to 40	40	50 to 60	60 to 80	80 to 100
Cottonwood	Mississippi Valley	10 to 15	15 to 18	20	25	30 to 35
Cypress, bald	Louisiana	15 to 25	20 to 30	30 to 40	45 to 60	50 to 70
Elm, white	New York	25 to 35	30 to 50	45	60	
Fir, balsam	do	55 to 75	80 to 100			
Fir, Douglas	Washington	15 to 25	20 to 30	30 to 40	50	70 to 80
Gum, red or sweet	Missouri	30	40	50	60	70 to 80
Hemlock	Michigan	40 to 80	50 to 100	80 to 130		
Hickory (mockernut)	Ohio Valley	40 to 50	50 to 60	70 to 80	90 to 100	
Locust, black	Kentucky	20	30 to 40			
Maple, sugar or hard	Michigan and Wisconsin	60 to 80	80 to 100	100 to 130		200

Oak, black	Southern Appalachians	25 to 30	35 to 40	50	80	130
Oak, red	do	25 to 30	30 to 40	45	60	100
Oak, white		30 to 50	40 to 80	60 to 100	90	160
Pine, jack	Minnesota	30 to 40	35 to 50	80		
Pine, loblolly	South Carolina	20 to 30	25 to 35	35 to 40	45 to 55	60 to 80
Pine, long-leaf	Texas	30 to 45	40 to 55	50 to 80	80 to 100	130
Pine, red or Norway	Wisconsin	25 to 35	30 to 40	35 to 55	50 to 75	60 to 100
Pine, scrub	Maryland	20 to 30	30 to 40	50 to 70		
Pine, shortleaf	North Carolina	15 to 20	20 to 30	25 to 50	30 to 80	60 to 130
Pine, slash	Georgia	15 to 20	20 to 25	30 to 40	45 to 60	
Pine, white	New York	20 to 30	25 to 40	30 to 45	45 to 60	90
Poplar, yellow or tulip	Tennessee	25 to 30	30 to 40	40 to 50	55 to 80	100 to 120
Spruce, red	New Hampshire (second growth)	40	70			
Tamarack	Minnesota	50 to 65	80 to 100	150		

[1] All diameters were taken 4 feet 6 inches from the ground.

U. S. D. A.—10-1-26

GRAZING

Range and Pasture Plants

General.—The vegetation of that portion of the United States lying west of the one hundredth meridian may be classified as forest, grassland, and desert.

Forests.—The great forests occupy the Cascade, Sierra, and Coast Ranges, and most of the slopes between the Coast Ranges and the Pacific Ocean north of San Francisco Bay. They also extend down across the Rocky Mountains and occupy all the more elevated land in Washington, Oregon, Idaho, Montana, Wyoming, Colorado, Utah, New Mexico, and Arizona. The western forests may be divided into woodland and timberland.

Woodland.—The woodland is composed of two divisions—the chaparral and the pinyon-juniper woodland.

Chaparral: This woodland consists of stunted hardwood trees and shrubs. It lies below the yellow-pine forest and above the desert-shrub and Pacific grassland. It is most extensive in California, but may be found also in Nevada, Utah, Colorado, and Arizona. In some places the chaparral is so dense that grazing animals can not readily make their way through it. Elsewhere it consists of open brush or forest, the interspaces being occupied by grasses. The open portions are valuable as forage land, and since the grasses are cured on the stalk they have a carrying capacity of 10 to 15 head of cattle "yearlong" per section. Throughout the whole of the chaparral zone, long periods of drought occur, and feed shortage is likely to have a serious effect on the industry.

Pinyon-Juniper: The pinyon-juniper zone lies just below the yellow-pine forests. It is most abundant in western Texas, the southern Rocky Mountains, Arizona, Nevada, on the eastern slopes of the southern Cascades, and on the Sierras. It consists of an open stand of pinyon or juniper trees growing on rough land, shallow or stony, which bears a small amount of forage. There are long periods of drought, but grazing is almost continuous. The carrying capacity is low.

Timberland.—The timberland may be divided into three major groups—western yellow pine and Douglas-fir forest, cedar-hemlock forest, and spruce-fir forest.

Western Yellow Pine and Douglas Fir Forest: The great forests of the Rocky Mountains, the Sierras, and the eastern edge of the Cascades are for convenience here included in this class. This area includes forests of yellow pine, where the large trees stand far apart over a grass cover. The region is admirably suited for grazing, but is not of high carrying capacity. There are also forests of yellow pine, sugar pine, and incense cedar. These are found, for the most part, on the western slopes of the Sierras and coast ranges in California. This forest type is dense, and grazing is not so important as in yellow-pine forests. Rocky Mountain Douglas fir forests lie at a somewhat higher elevation than yellow pine, and, except for open parklike spaces, are not well suited for grazing. Within this group may also be listed lodgepole pine forests, many of which grew up after fire, but some of which are probably primeval forests. The growth of lodgepole pine is dense, and the land has little or no forage value. The western larch and Douglas fir forests of northwestern Montana and Idaho may also be included. This forest is dense and not especially valuable as grazing land.

Cedar-Hemlock Forest: Probably the most valuable block of forest land in the United States. It is divided

into two principal types: (1) The western white pine and western larch forests of northern Idaho and parts of Montana and Washington, and (2) the Pacific coast Douglas fir forests of western Oregon and Washington. When cleared, the land is productive for agricultural purposes, but in its natural condition it is not valuable as grazing land.

Spruce-Fir Forest: At high altitude in the Rockies, Cascades, Sierras, and in Arizona, this forest forms a dense stand. It lies above the western yellow pine and Douglas fir forest, and because of the dense stand the timbered area has little value for grazing. The extensive openings in this Alpine timber type and the mountain meadows furnish excellent summer grazing. Such areas have wet meadows which will carry for a 4-month season from 100 to 250 head of cattle, and dry meadows which will carry from 50 to 100 head of cattle, or from 150 to 400 head of sheep per section.

Grasslands.—Except for a small portion of the prairie, which extends on sandier land west of the one hundredth meridian, the grasslands of the region are confined to the following principal formations: (1) Short grass, or plains grassland; (2) bunch grass, or Pacific grassland; (3) mesquite grass, or desert grassland; and (4) mesquite-desert grass, or desert savanna.

Short grass.—The short grass or plains grassland is the most valuable for grazing. It occupies practically the whole area between the one hundredth meridian west longitude and the mountain front, and extends into the high plateaus of New Mexico and Arizona. It is composed of low-growing grasses of high forage value, which cure on the stalk and afford excellent grazing during winter when not covered with snow. The carrying capacity, dependent upon the diversity of the grass cover, is from 50 to 80 head of cattle per section for eight months to a year.

Bunch grass.—In the Palouse region and the areas lying just below the yellow pine zone in the Northwest, and also in valleys in California, such as the Sacramento, the San Joaquin, and the Salinas, is a grassland which was probably originally composed of bunch grasses. This has been good grazing land, with a carrying capacity of 25 to 60 head of cattle per section for six to eight months. However, over much of the area, especially in the South, the perennial grasses have been killed by overgrazing, and the region is now characterized by annual grasses and weeds, which, although they afford a considerable amount of forage, are not all nutritious. The carrying capacity of such areas is from 10 to 30 head of cattle per section for six to eight months.

Desert grass.—This grassland occupies the mesa lands of southern Arizona, New Mexico, and western Texas, and consists of highly nutritious perennial grasses, which grow after summer rains and afford excellent pasturage for 20 to 35 head of cattle per section for the year.

Mesquite and desert-grass savanna.—This grassland does not differ markedly from the desert-grass or short-grass land, except that over the grass cover are scattered trees of mesquite. The mesquite trees afford some forage, since their pods contain a large amount of sugar and are eaten readily by grazing animals. As a rule this grassland is not so valuable for winter forage as the drier desert grassland farther west. The carrying capacity is from 10 to 25 head of cattle per section a year.

Alpine grassland.—Lying near and above the timber line on high mountain peaks and ridges of the central and northern Rockies, Cascades, and the Sierras, is a grassland composed largely of highly palatable grasses

and weeds, which affords considerable pasturage during the summer months. This grassland with intermixed types furnishes a considerable part of the summer range for the sheep grazing on the national forests, and will carry from 200 to 500 head of sheep per section for two and one-half to three months.

Desert.—The desert-shrub regions of the United States may be divided into three types: (1) Sagebrush (northern desert shrub), (2) creosote bush (southern desert shrub), and (3) greasewood (salt desert shrub).

Sagebrush (northern desert shrub).—The sagebrush desert occupies most of the intermountain valleys lying in Washington, Oregon, Idaho, Nevada, Utah, Wyoming, Colorado, northern New Mexico, and Arizona. It consists largely of small deciduous shrubs, which stand some distance apart. In the interspaces, perennial grasses and other plants grow and add considerably to the forage value. This is largely the spring, fall, and winter range for sheep and cattle. Winterfat, which occupies large areas in Utah and Nevada, and will carry 50 to 100 head of sheep per section for the winter; bud-sage, early spring pasturage for sheep; and, to a lesser extent, salt sage are also found in the sagebrush areas. Shadscale and sagebrush are valuable as winter forage for sheep. Desert grasses of the bunch-grass type often form an important part of the vegetation and increase the forage value at higher elevation.

Creosote bush (southern desert shrub).—This growth extends across the southern portion of California, Nevada, Arizona, New Mexico, and into southwestern Texas. It often contains spiny plants and cacti and produces little forage, except in sections where summer rains cause rapid growth of annuals. In the eastern part, where succulent plants, mixed with desert grasses have increased the forage value, this portion of the southern desert affords grazing land of low carrying capacity in the Southwest region of the United States. In the valley of the Colorado River the forage value of the vegetation is very low.

Greasewood (salt desert shrub).—This is not extensive, and is limited to drainage channels and the lowlands lying within the northern and southern desert-shrub region. As a rule, alkali is abundant and a permanent moisture supply is available. In this region salt and tussock grass provide small areas of good grazing land, with a carrying capacity of 20 to 30 head of cattle per section per year.

Stock-Poisoning Plants.—Many species of poisonous plants are found in the range country and are able to persist for the reason that no cultivation is attempted on range lands. Some of the plants that cause poisoning are not extremely poisonous and produce injurious effects only after being eaten in considerable quantity. In seasons of short grass, the stock may be forced through hunger to eat unpalatable or poisonous weeds that they otherwise would not touch. The effects of poisoning do not always occur immediately after the plants have been eaten, so that sometimes animals show the first symptoms of sickness when they have traveled considerable distance beyond the poisonous plant. The heavy losses of the range are caused by comparatively few plants.

Aconite.—Flowers of the aconite have the peculiar form from which the plant has been known as monkshood, and in most regions they are much darker in color than the larkspurs. The plant should be distinguished from larkspur, because it grows in great abundance in some

localities where larkspur is comparatively rare. This is especially true of certain parts of the Yellowstone Park, where the swampy regions are blue with aconite in the summer months and larkspur is rarely seen. In other parts, however, like the area between the Yellowstone Lake and the Grand Canyon, the larkspur is abundant and the aconite comparatively rare. Experimental work has demonstrated that aconite does not poison livestock on the range.

Larkspur.—Some of the larkspurs are commonly called aconite by stockmen. They grow abundantly in most of the higher range country in the mountains and are responsible for heavy losses of cattle, but they do not poison sheep or horses. The symptoms of poisoning are a rapid respiration and pulse, slight lowering of the body temperature, profuse sweating, and occasional bloat. The poisonous effect comes on quickly after eating, and ordinarily the animals either die or recover in a short time. The roots are particularly poisonous, but animals rarely eat anything except the parts of the plant above ground. Animals can be treated successfully if found in time. In their struggles, animals poisoned by larkspur throw themselves with their heads downhill, and in this position the stomach and intestines press upon the lungs. A large number of cases will recover if the animal is turned with its head uphill and let alone. It is also desirable under such conditions to give the physostigmine remedy hypodermically. The remedy has the folowing formula:

Physostigmine salicylate	1 grain.
Pilocarpine hydrochlorid	2 grains.
Strychnine sulphate	½ grain.

This formula applies to an animal weighing 500 to 600 pounds. Twice this dose should be given for a steer or cow weighing 1,000 pounds or more. These materials can be procured from any dealer in drugs. Grubbing of larkspur from many national-forest ranges has been done at a cost of less than half the annual saving in losses of cattle.

Cocklebur.—The cocklebur is widely distributed in the range country and has been the cause of losses of cattle and hogs, especially in Oklahoma, Texas, and New Mexico. All the poisoning is caused by the young plant in the cotyledon stage. Young pigs are especially susceptible. No reports have been received of losses of sheep from cocklebur poisoning under range conditions. Based on the statement that pigs fed on fresh milk are not poisoned, experimental work has shown that beneficial results follow the administration of oils or fats. For this purpose linseed oil, bacon grease, or lard can be used.

Coffee bean.—This shrub grows in the Gulf region and extends as far north as the northwestern border of Texas. It likes to live with "its feet in the water" and is found in great profusion along ditches and sluggish streams in southern Texas. So far as known, the green plant does no harm. The seeds are poisonous, and cases of poisoning occur in the winter on areas where feed is scanty. All the known cases of poisoning are confined to sheep and goats. Animals show depression, generally accompanied by diarrhea. In fatal cases the symptoms are not especially pronounced, but the animals become weak, have labored breathing, and die with very little struggling. Considerable time elapses between the feeding and the appearance of symptoms, sometimes as much as 24 hours. The symptoms may continue for several days, so that poisoned animals require special care until after complete recovery.

Death camas.—Distributed from British Columbia to Nebraska and westward to California. Grows at altitudes from 1,500 to 8,000 feet. Known by various common names, such as crowfoot, lobelia, and wild onion in different parts of the country. It is a smooth, single-stemmed, perennial plant with onion-like bulb, narrow leaves which appear early in the spring, spreading apart in such a manner as to suggest the name of crowfoot. The leaves are somewhat more succulent than grass and appear before most grasses have started in the spring. Appears tempting and is frequently eaten by horses, cattle, and sheep, but the principal losses are of sheep. Throughout the Western States losses are reported from eating this plant, about 20 per cent of the cases being fatal. The bulb is also poisonous to man. The symptoms of poisoning are uneasiness and irregularity in movement, accompanied soon by spasms and rapid breathing. Later the animals show almost complete paralysis and lie on their side with rapid respiration and frequent irregular pulse. In some cases death results within one or two hours, while in others the animal may lie on its side one to two days. There are no medicinal remedies which can be used effectively. The important thing is to avoid the possibility of the sheep eating any large quantity of the plant. Unfortunately, the plants are quite toxic, so that comparatively small quantities may produce harm.

Fern.—Common bracket fern is one of the poisonous plants, although the losses from it probably are not large. There have been comparatively few reports of such losses, and those are confined largely to the Northwest. There is no doubt that ferns will poison both cattle and horses and probably sheep, and care should be taken that hungry animals do not have an opportunity to consume any large quantity.

Greasewood.—Well-known plant common on the alkaline plains of the West. It is a spiny shrub growing from 3 to 9 feet in height, with narrow, fleshy leaves not exceeding 1½ inches in length. While greasewood is grazed by sheep on the winter range with no bad effects, there have been, under some conditions, severe losses of sheep. However, the plant forms an important element in the winter forage. If very hungry animals eat a large quantity in a short time, fatal results may follow. The poisonous effects are produced by the sodium and potassium oxalates in the plant.

Laurels.—Most laurels are quite poisonous to livestock. Only small quantities are necessary to produce fatal results. They are not found in all the range States, but several species on the California ranges and in the States north, as well as in the Eastern States, have caused serious losses. These plants are usually recognized by sheepmen and to a large extent avoided. The symptoms are practically the same in all cases of laurel poisoning. There is a salivation resulting in frothing at the mouth, nausea ordinarily accompanied with vomiting, depression, weakness shown by a staggering gait or inability to stand, and irregular respiration. Grinding of the teeth is frequently noticed in sick animals. Little can be done in the way of remedial treatment. Purgatives may be given, such as Epsom salt, in doses of 4 ounces.

Loco weeds.—Loco, meaning crazy, is of Spanish origin, and for many years has been applied to a disease common among horses, cattle, and sheep. Loco weeds are leguminous plants growing in the arid and semiarid regions of the West. Three distinct kinds of loco

plants are known, the "white loco," the "purple loco," and the "blue loco." Of the three loco plants, the purple affects horses, the blue affects mostly horses, but also cattle and sheep, and the white causes heavy losses of all three classes of animals. Loco poisoning is confined largely to the region east of the Continental Divide, and the plants are particularly abundant in the Great Plains. Cultivation destroys the loco weed, so that as the area of farm lands increases, loco poisoning decreases. The weeds may be dug out by cutting the root 2 or 3 inches below the surface of the ground. Locoed animals may recover under careful feeding, but the cure is hastened by the use of arsenic in the form of Fowler's solution for horses and strychnine for cattle. For horses give daily doses of 4 to 6 drams or 20 cubic centimeters in the grain or in the drinking water. This dose is roughly equal to 4 to 6 teaspoonfuls. For cattle give strychnine in daily hypodermic doses, not to exceed three-twentieths or four-twentieths of a grain. Locoed animals are very sensitive to strychnine, and extremely small doses should be given. Treat animals for at least 30 days. Recovery is a very slow process. Stock commonly contract the habit of loco feeding in times of short feed. Feeding hay during the period prevents many animals from acquiring the habit.

Lupines.—Many different species are found in the Western States, where the plants frequently grow in large masses. Known under a number of common names, such as sundial, old maid's bonnet, Quaker's bonnet, Indian bean, wild bean, blue pea, and blue bean. Horses are especially fond of lupine and will sometimes eat the green plants with greediness. The plants may be eaten in large quantities without harmful results, but the fruit is poisonous and causes heavy losses of sheep. These losses occur only when the plant is in pod. The season of ripening is late in the summer. Sheep must eat a considerable quantity before being injured, and many losses occur in the fall when sheep are driven from summer to winter range. Symptoms are labored and heavy breathing and passing into a state of coma, the animal sometimes dying in convulsions. The animal may run around wildly, butting into objects. No form of remedial treatment can be used advantageously for range animals. Poisoning in most cases can be avoided, even where the plant is abundant, by careful handling of flocks, special care being taken to see that hungry sheep are not grazed on fields where there is much lupine.

Milkweeds.—Milkweeds are found abundantly in most of the sections of the range country, but some of the poisonous species have a somewhat limited distribution. Heavy losses of livestock frequently are caused by these plants.

Whorled Milkweed: Found in Arizona and New Mexico to central Utah and central Colorado. The stems are erect, single, or several, sometimes branching "near woody" at base, and from 1 to 5 feet high. It flowers in June and July, the blooms often continuing until September. Irrigation ditches are ideal for the transportation, germination, and development of seeds. Plant is poisonous to horses, cattle, and sheep, but most of the reported losses have been of sheep. The most marked symptoms are violent spasms. No medicinal remedy gives satisfactory results. Reliance must be placed on the destruction of the plant and such care of stock as will prevent hungry animals from coming into contact with masses of the weed.

Mexican Whorled Milkweed: Plant ranges from Mexico northward through California, western Nevada, and southern Washington to eastern Idaho. Has long been considered a stock-poisoning plant, particularly dangerous to sheep, but there is not much definite knowledge of the symptoms produced by it or of its toxic dosage. It produces effects very similar to those produced by the other whorled milkweeds.

Woolly Pod Milkweed: So far as known, grows only in California and in that State is confined to the western portion, except in southern California where it is found across the full width of the State. Resembles very much the ordinary showy milkweed; however, the tips of leaves are more blunt and the pods more woolly. Losses have been confined almost entirely to sheep, but the plant is equally poisonous to cattle. The most marked symptom of poisoning is depression, which is shown in the lowered head and humped back of the animal. This depression is followed by weakness, the animal lying down most of the time. Animals rarely eat this plant except when they are deprived of other forage. No effective remedies for the poison are known.

Oaks.—Oak poisoning has occurred in many parts of the range country, but has been more destructive in Utah and western Texas. Oaks should not, strictly speaking, be considered as poisonous plants. Oak browse is known to be very valuable and on many ranges, particularly those that are used by cattle, can be used for grazing with positive benefit. Continuous feeding on oak leaves may produce sickness which sometimes ends in death. The loss of livestock on an oak range is from 2 to 3 per cent. The specially marked symptoms are constipation, feces containing mucus and blood, emaciation, and edema. A diet composed exclusively of oak leaves does not form a sufficient nutritious diet to permit normal gains of weight. Most of the cases of poisoning occur in the spring, because on the range at that time there is a scarcity of other forage and the young leaves are attractive.

Rayless goldenrod.—A disease known commonly as "alkali disease" or "milk sickness" has caused many fatalities of domestic animals in certain localities in New Mexico, Texas, and Arizona. The plant which has been most commonly thought to be connected with the disease is popularly known as "rayless goldenrod." Horses, cattle, and sheep may be poisoned, and there is evidence that burros may be affected by it. The first symptom noted is marked depression. The animals are inactive, appear stupid, usually stand in a humped position, and move with a stiff gait, the stiffness being especially marked in the forelegs. Constipation occurs in all cases, but may be preceded by a period of diarrhea. In the later stages the feces are not only hard but bloody. Marked muscular trembling is present; in fact, the disease is sometimes known as "trembles." No definite line of medicinal treatment is recommended. A purgative like Epsom salts, administered to correct the condition of constipation and to aid in the elimination of the poison, is suggested. If the animals are removed from the plant in the early stages of the disease and supplied with an abundance of good feed most of them will recover without any further treatment.

Sneezeweed.—Strong perennial plant, with one or several stems, growing to a height of 1 to 3 feet. Often develops a large crown and spreads vegetatively by this crown. From the color of the flowers it is sometimes called "yellow-weed," and some stockmen call it "sun-

flower," but in Utah it is most commonly known as "sneezeweed." The western sneezeweed has become very abundant on some of the more elevated and overgrazed stock ranges of the West, especially in Utah. The plant has proved to be the cause of the disease of sheep known as the "spewing sickness," and also has been shown to be poisonous to cattle. Symptoms resemble those of other kinds of plant poison, but are not so violent as in some and are not accompanied by convulsions. No medicinal remedy has been found which can be used effectively in treating the poisoned animals. Little can be accomplished by attempts of extermination of the plant. Avoid grazing heavily where the plant is abundant.

Water hemlock.—Most poisonous of all the plants in the United States. There are several species of Cicuta, commonly known as "cowbane," "water hemlock," "parsnip," or "wild parsnip." Other names less common are "snake root," "snakeweed," "beaver poison," "muskrat weed," "spotted hemlock," and "spotted parsley." The plant is a smooth perennial, 2 to 5 feet high, with long fleshy roots, large-branched leaves, and flat-topped clusters of greenish-white flowers. It grows in swamps and damp valleys and frequently is abundant along irrigating ditches. The rootstock and roots are violently poisonous, and a very small quantity is sufficient to kill any animal that eats it. The losses of domestic animals are mainly of cattle which either obtain the rootstocks that have been plowed up along irrigating ditches or find them along the watercourses in mountain valleys where they have been washed out by high water. Symptoms are frothing at the mouth and violent convulsions, which in a short time ordinarily end in death. When cattle are severely poisoned the convulsions are so violent that it is almost impossible to administer a remedy. No effective remedy is known, and death is almost certain to follow poisoning. Frequently, human beings, especially children, are poisoned by Cicuta, in which case if an emetic can be given promptly, so that the stomach is quickly emptied, recovery usually takes place. Because of the fact that ruminant animals can not empty the stomach by vomiting, this remedy can not be applied to them. The losses from cicuta poisoning are not very heavy, but individual stockmen occasionally lose a number of animals.

Wild cherry.—Leaves of wild cherry may be extremely poisonous, and under certain circumstances animals may be killed by eating this plant. Losses are mostly confined to sheep and cases of poison ordinarily occur along drives that are bordered by wild cherry and where there is little else for the animals to eat. It has been found that the rather widespread idea that cherry leaves are specially dangerous when wilted is erroneous. Sheepmen should avoid trails that are lined with wild cherry. Poisoning is due to prussic acid, and death results very quickly. No treatment is likely to modify the results.

Protective measures.—Very little can be expected from medicinal remedies to reduce the losses from poisonous plants. It is true that such remedies will help in the case of locoed animals and will save life in the case of larkspur poisoning of cattle. Reliance should be placed, not on remedies, but upon prevention. Animals must be so well cared for that they will not be tempted to eat poisonous plants. Larkspur can doubtless be eradicated within a limited area. The locoes in pastures can be eradicated with little difficulty, but on the open range dependence must be placed upon avoidance rather than eradication. Death camas does its harm upon the open range, where it occurs in such large masses that eradication is impossible. In the matter of water hemlock,

farmers and ranchers may accomplish much by digging it up along their irrigation ditches. Losses from poisonous plants can be prevented by careful handling of herds. It should always be remembered that animals are not likely to eat poisonous plants by preference, but that under starvation conditions they may be driven to the use of such material for forage with most disastrous results.

Range Management

Classes of Grazing Lands for Livestock.—The main factors which, combined, determine the class of livestock for which the range is best suited are: (1) Character of forage, (2) topography, (3) distribution of watering places, (4) animal pests, and (5) protection of game, timber growth, and watersheds.

Character of forage.—Cattle and horses use a range to better advantage than sheep. Sheep relish tender green foliage and the seeds of many grasses, but eat sparingly of coarse or dry grass foliage. Cattle consume a much larger proportion of the coarse grass forage. Horses, even more than cattle, prefer grass to weeds and browse. Weeds are much more palatable to sheep than to cattle or horses. Only a small percentage of weeds are palatable to cattle, and even fewer are palatable to horses. Sheep show discrimination in their choice of weed forage, but they will eat parts or all of most weed species on closely grazed range. Both sheep and cattle eat considerable browse, but sheep have a tendency to browse more than cattle, and more of the browse species of range lands appear to be palatable to them than to cattle. Cattle reach higher than sheep and get more forage from high-growing species, such as scrub oak. Horses browse but little. Browse furnishes the bulk of range feed for goats throughout the year, with grasses second and weeds third. Sheep use the brush range, provided the area is not too wet. Cattle will use dense brush range, but prefer the open range.

Topography.—Cattle prefer level or rolling country. Altitude makes little difference if the stock have been raised on the range. Under necessity they will use rough range, but it is difficult to get equal distribution of cattle without more watering places, salt grounds, fences, and herders than are ordinarily included in the equipment of such ranges. Cattle on rough, rocky range frequently become footsore, especially the bulls. As a consequence, there is danger of local overgrazing, and the number of bulls necessary for each 100 cows to keep up the calf crop is nearly double the number used on level or rolling range. Sheep do the best on smooth range, but can use rough or rocky range. Altitude is not a factor, except that sheep do best where it is cool during the summer. More even distribution of grazing on rough range can be obtained with sheep than with cattle, since sheep are under full control of the herder. Cattle are difficult to control without division of the range by fences into comparatively small pastures. Goats do best on well-drained open areas which are free from continued heavy rains. Horses will readily use rugged range if raised on it.

Distribution of watering places.—Cattle need water at least every two days. In rough country they should not have to travel more than one-half to 1 mile to water, and in level or rolling range not more than 2½ miles. Sheep can go from several days to several weeks without drinking, depending upon succulent weed feed, the temperature, and the amount of rain and dew. For goats abundant water should be available on ranges during the spring and

summer. Usually snow will furnish enough water on the winter range. Horses can go long distances to water, and will of their own choice graze out on high, open grass ridges far from watering places.

Animal pests.—The presence of bloodsucking insects sometimes makes it impracticable to graze cattle or horses on ranges which otherwise are well suited to them. These pests are numerous and most troublesome at the higher elevations, where there is usually a heavy snowfall and rainfall and a short dry season. These conditions are favorable for the breeding of flies, gnats, and mosquitoes during the time the stock should be on the range. In some cases the ranges may be grazed after the fly season has passed, but usually the season is too short in the high altitudes. Sheep and goats are annoyed by these insects, but much less than cattle or horses.

Protection of game.—Forage habits of elk and deer are similar to those of cattle and sheep. Both elk and deer show a greater preference than cattle for weeds and browse. Game animals usually choose areas not well suited to the grazing of domestic animals. Mountain sheep and mountain goats are seldom found in summer or winter on ranges accessible to any class of domestic stock. Moose are usually found in rolling timber country, where bogs, ponds, and lakes are numerous. The presence of certain game animals in numbers sufficient to utilize a considerable part of the forage may necessitate restriction of the number of stock that can be grazed on any particular area.

Protection of timber growth and watersheds.—Grazing within certain limits, properly managed, does not interfere to an unwarranted degree with the protection, development, and conservative use of the forests and watersheds. Where the intensity of the grazing is the same, sheep graze young growth of more timber species than do cattle, and cause greater injury to young growth and to watersheds, though on steep slopes with loose soil cattle grazing may be more destructive to the watershed than sheep grazing. Injury to tree growth by cattle and horses is negligible, if overgrazing and bad management of stock are avoided. Injury to tree growth by sheep depends greatly upon the character of the forage, increasing as the proportion of forage not suited to sheep increases. Timber reproduction on dry grass ranges or other ranges where there is little succulent weed growth or browse suitable to sheep is especially subject to injury by sheep grazing if the forage is fully used. Sheep in herds on steep slopes where the soil is loose may trample out tree seedlings.

Use of Range by Different Classes of Stock.—On mountain lands the range units wholly suited to exclusive use by one class of stock are small in number as compared with those that can be fully utilized only by two or more classes. One to three classes of stock may be grazed in numbers corresponding to the quantity of forage that can best be used by each class.

Cattle and sheep range.—Common use by cattle and sheep will make possible a greater utilization of all the forage on areas having a mixture of coarse grasses palatable to cattle, or weeds and brush of low palatability for cattle but of value to sheep, or an appreciable area of wet meadow range, or where part of the range is rough and at some distance from water. Both classes need not be grazed on the same area if either will utilize satisfactorily the available feed. There has been a progressive tendency to devote to cattle grazing range that is best suited to sheep, or at least to crowd more cattle on such ranges than the type of

vegetation suited to their own use can support, with resultant damage to the sheep industry.

When cattle and sheep are grazed together care must be exercised that the number of each class will be adjusted to the quantity of available forage suitable for it. If this is not done, overgrazing will occur, and the welfare of both the range and the livestock will be impaired. If a range is stocked with cattle on a basis that will utilize all the feed suitable for cattle, it will be necessary to reduce the number of cattle when sheep are added, in order to allow for the utilization of some of the cattle feed by the sheep. A similar reduction in sheep must be made on range fully stocked with sheep when cattle are added. Best results will be obtained when sheep are grazed under the "open-herding and bedding-out" system and when cattle are so salted and herded that uniform utilization is obtained of the feed available for them. Occasionally it has been found advisable to graze the class of stock best suited to the range during the main growing season and then to allow the other to graze for a short period near the close of the grazing season. On large ranges it may also be advisable to classify small parts of the range for use by sheep or cattle when the rest is used by the other class of livestock. The old-time belief that cattle will not graze on a range used by sheep is erroneous. It originated mainly when the ranges were badly overgrazed and little or no feed of any kind was left for the cattle. Overgrazing and an excessive number of either class must be avoided.

Cattle and goat range.—Many brush ranges are now grazed by cattle, but such range could better be used by goats alone, or goats and cattle together, thus increasing utilization, production of animal products, and financial returns. The basis of stocking such ranges with cattle should be slightly below that required properly to utilize the herbaceous and more palatable browse plants. Such a degree of utilization is essential for keeping cattle in breeding condition in order to obtain an economic calf crop and growth of young stock. Goats could then be added in such numbers as would bring the utilization of the herbaceous and highly palatable browse plants to full use.

Sheep and goat range.—Those ranges supporting a heavy stand of browse of low or moderate value for sheep, but more palatable for goats, may well be used by both classes in common. Ordinarily sheep will give as full utilization as is advisable on ranges with open stands of browse, but where the management of both classes can be adjusted to prevent undue conflict, greater utilization will occur and greater financial returns are possible. With purebred Angora goats, or where fenced pasture is used for grazing, greater returns are obtained from grazing both classes. With grade goats and grade sheep in separate herds, however, the extra cost of running two herds on the same area may not be offset by the returns from the goats less the loss in return from the sheep, the number of which have necessarily been reduced to allow both classes to utilize that part of the feed palatable to both.

Cattle, sheep, and goat range.—In pastures, particularly in Texas and Oregon, and occasionally on open-range areas, all three classes of stock have been grazed together successfully. Each class should be adjusted to the feed available for it and be so managed that undue conflict will not arise. A good grade of all three classes of stock is necessary to be successful.

Horses on the cattle range.—A few horses may be grazed to advantage on sheep range, cattle range, or

range used by both sheep and cattle. The horses will use to advantage grass range not well suited to sheep and too far from water or too rough for full use by cattle. It is better to graze saddle or work horses in a small pasture provided for that purpose. The better results from the breeding herd will more than offset the cost of such pasture.

Grazing Seasons—*Periods and degree of grazing.*—(1) Season-Long Grazing: Grazing a pasture continuously during the whole season; if grazed during entire 12 months, then called "yearlong" grazing.

(2) Continuous Grazing: Grazing constantly throughout the season.

(3) Rotation Grazing: Grazing two or more pastures or areas in regular order, with definite resting periods. This method, where only two fields are involved, is sometimes called "alternate" grazing.

(4) Intermittent Grazing: Grazing a pasture now and then, regardless of definite periods.

(5) Premature Grazing: Turning animals on the pasture too early in the season, before the ground is firm and before the grasses have gained a sufficient start.

(6) Deferred Grazing: Keeping animals off a pasture until after the seed crop is mature, primarily to insure natural reseeding, but also in many cases to stimulate vegetative reproduction.

(7) Season-Long Resting: No grazing during one whole season, and incidentally natural reseeding.

Of the above, deferred grazing and season-long resting definitely provide for natural reseeding, but the others do not include such provision.

The above terms relate to the period of grazing. Other terms are used mostly to denote the degree of grazing.

(8) Carrying Capacity: Ratio of animals to the unit of area that will furnish ample sustenance; thus one cow to 2 acres; three sheep to 1 acre.

(9) Close or Heavy Grazing: Pasturing as many animals on a given type of pasture as will furnish good feed to the animals and at the same time not injure or destroy the plants.

(10) Overgrazing: Grazing which results in the destruction of desirable vegetation, sometimes called "destructive" grazing.

(11) Undergrazing or Light Grazing: Pasturing below the carrying capacity of the area. In humid regions undergrazing often results in pasture deterioration by the ingress of weeds.

Systems of grazing.—Any one of the grazing-period methods may be used first on one field and then on another in a series of fields or pastures. This grazing may be continuous or intermittent, light or heavy, as may be desirable. The animals may be all of one kind or of two or more, grazed together or in succession. A definite method of grazing used in respect to two or all of these three factors—periods of grazing, rate of grazing, and kind or kinds of animals used—may be called a grazing system. Where there are large areas of land usable only for grazing purposes in the Western States, most of the livestock is grazed during as much of the year as possible. The land may be divided into summer and winter pastures, or it may be further subdivided so that cows are run in one pasture, yearlings in another, and the older steers in still a third. The pastures may be used in rotation, whereby given areas are grazed for only a definite part of the year. Sometimes one of the pastures is held until the grasses have matured a seed crop before being grazed.

Winter range.—Restricted mostly to the valleys and basins of the intermountain and southern range States,

where the rainfall is light and where water or snow is available for livestock only during the winter months. The vegetation in such areas consists largely of shrubs and weedy annuals, many of which are not relished by cattle but are readily grazed by sheep. In the more northern desert areas the winter ranges are available for a 4 or 5 month period, whereas in the Mohave-Gila desert the grazing period is usually restricted to a few weeks in the late winter and early spring. In case the spring rains fail, these latter areas are usually unavailable. In the irrigated and dry-farming districts much late fall and early winter grazing is obtained by giving the animals the run of stubble fields, the aftermath of hayfields, especially alfalfa, and by pasturing them on marshy lands.

Summer range.—Found mostly in the mountains and, because of the shortness of the growing season, summer ranges are available only during the warmer months. The grazing season varies from approximately three months in some of the higher altitudes in the northern range States to about six months in the mountains of the Southwest. Since this is the period of greatest livestock development, plenty of palatable feed, water, and shade should be available.

Yearlong range.—The " yearlong ranges " are those areas where grazing can be carried on during practically the entire year. Most of these ranges are covered with grass, and in the northern range States they are fairly free from trees and brush. A large part of the less rolling yearlong range in the northern Great Plains and Columbia basin, where there is sufficient rainfall for the growing of crops, has in recent years been converted into farms. In the semiarid Great Plains region the grazing season is now largely dependent on the farm practice. Formerly yearlong grazing prevailed throughout the region. In the northern portion of the Great Basin the range, although it can generally be grazed throughout the greater part of the year, is now so restricted in area that it will carry only a part of the total livestock. For this reason it is generally reserved for spring and fall grazing, and serves as an intermediate range for animals traveling between the summer range and the winter range or feed lots. In the southern range States, where land is generally too arid for farming, there are still large areas of yearlong range. The higher levels are used during the warmer season and the lower levels in winter. The distance from one to the other is usually only a few miles.

Spring and fall range.—Those areas at intermediate elevations where the feed starts earlier than on the high summer ranges, and which, when protected during the summer growing season, afford feed until the livestock are placed in the feed lots or on the winter range, make suitable spring and fall range.

Begininng the grazing season.—If the range plants are grazed before they have become well developed they readily lose their vigor, and if this early grazing continues they will be killed, with a resultant reduction in grazing capacity. The feed at this time is full of moisture, and it is difficult for an animal to obtain the necessary amount of nourishment. Animals lose weight and may die of starvation. The proper development of the important forage plants should be used as a guide for determining range readiness. It is important to avoid admitting stock before at least one-fourth of the heads of the earlier forage grasses have begun to show or before the leaf sheath involving the head is swollen and conspicuous. The greatest danger from trampling

and packing is over by the time the main forage plants have been growing about two weeks.

Seasonal grazing.—Established grazing periods sometimes cover spring, summer, and fall range varying perhaps as much as 5,000 feet in altitude. Vegetation is delayed about 7 to 10 days for 1,000 feet of increase in elevation, making a total of 35 to 50 days' difference between the lower and the upper limits. In herding sheep a definite plan can be followed to adjust the time of grazing at a given altitude so as to correspond with the development of the vegetation. The control of cattle is usually inadequate to accomplish this desired seasonal grazing. The cattle drift to the higher altitudes before the vegetation should be grazed. Where this is the case the object of establishing a grazing period is accomplished only on the extreme lower altitude. The remedy is to work for a logical division into spring range, extending to about July 1, and summer range, beginning about July 1, with corresponding control of cattle and horses.

Closing the grazing season.—The close of the spring grazing period is determined by the following factors: (1) Development and quantity of forage on the summer range, (2) grazing capacity of the spring range as compared with the summer range, (3) palatability of the forage on the early range and the thriftiness of the animals grazed, (4) water supply, and (5) need and value of the forage for fall grazing.

The close of the summer and fall grazing period is governed by the following factors: (1) Proper utilization, (2) weather conditions and the trampling of wet soil, (3) condition of the livestock, (4) availability of forage elsewhere, and (5) water supply.

The close of the winter range should be made when proper utilization of the old growth has been obtained and before the beginning of the spring growth. If the range is to be kept up and a normal forage crop produced over a period of years following, the vegetation must be given a chance to grow. This means that the stock should be removed at the beginning of the main growing season.

Carrying Capacity.—May be defined as meaning the number of stock of a given class or classes which a range will support for the period of the grazing season. The ideal sought is the maximum number of stock which the unit will support each season over a period of years without injury to the range, tree growth, watershed, or unwarranted interference with game and recreation. If this ideal is to be realized, both overgrazing and unnecessary undergrazing must be avoided. The rate of stocking in average years should always be conservative, even to the extent of leaving unused 15 to 25 per cent of the palatable herbage of the important range plants.

Determination of carrying capacity.—This problem has to be worked out on each individual area grazed. Proper utilization of each type under the conditions existing must be considered. Surface figures of grazing capacity must be materially qualified. It is first essential to eliminate from consideration all waste areas, which, because of inaccessibility, rock outcrop, barrenness, down timber, or other causes, are worthless. The density, vigor, palatability, and usability of vegetation on the remaining areas largely determine the basic estimate of the amount of stock which may be grazed for a given season. On national forests the carrying capacities are being determined by grazing reconnaissance on a forage-acreage basis, namely, density of vegetation multiplied by average palatability multiplied by surface acreage. The average

monthly forage-acreage requirement has been found to be 0.8 forage acre per cow and 0.3 acre per sheep. Adjustment in forage-acre allowance is made scientifically to meet specific factors on each division or allotment. This adjustment varies from as low as 0.5 of a forage acre per cow per month on large meadows with a long growing season up to 1.2 or occasionally more of a forage acre per month on badly depleted range, on areas where unseasonable use must be practiced, where game demands a considerable part of the feed, or where unusual watershed protection is necessary. This slight variation in forage acreage, however, compares with surface-acre requirements of from 1 to 15 acres per cow per month under the respective conditions. The greater possibility for accuracy in carrying capacity estimates by the forage-acre method will readily be seen.

Character of forage and estimated capacity of the western grazing of the United States

Area	Chief forages	Length of season	Area to support a cow
		Months	*Acres*
Northwest Great Plains.	Grama, buffalo, needle, and wheat grasses.	5–10	10– 30
Southern Great Plains.	Grama, buffalo, bluestem, beard, and mesquite grasses, and scrub oaks.	8–12	15– 35
Black Hills	Grama, buffalo, and bluestem grasses.	3– 5	25– 30
Central Rocky Mountains.	Blue, fescue, wheat, brome, and redtop grasses, Baltic rush, and "weeds."[1]	3– 6	15– 25
New Mexico-Arizona mountains.	Grama, fescue, beard, and wheat grasses; scrub oak, and mountain mahogany.	5– 8	12– 25
West-central Montana foothills and high plains.	Fescue, wheat, blue June, porcupine, brome, and grama grasses.	5– 7	15– 30
Northern Rocky Mountains.	Pine, wheat, blue, brome, and fescue grasses.	3– 6	20–150
Central Idaho	Pine, wheat, brome, fescue, and blue grasses.	3– 7	25– 30
Wasatch, Uinta, and Wyoming Mountains.	Wheat, porcupine, fescue, and blue grasses, bluebells and other "weeds,"[1] and browse.	3– 7	8– 25
Northeastern Nevada, southern Idaho, and central Oregon.	Wheat, blue, and fescue grasses, sagebrush, shadscale, and greasewood.	4– 8	35– 40
East-central Nevada mountains.	Wheat, blue, and fescue grasses, and browse.	4– 6	25– 50
Wyoming semi-deserts.	Salt grasses, sagebrush, shadscale, and greasewood.	2– 6	35–100
Utah, Nevada, Arizona.	Salt, grama, three-awn, and annual grasses, annual "weeds,"[1] sagebrush, winterfat, greasewood, shadscale, mesquite, palo verde, and cacti.	2– 5	50–150

[1] On the range "weeds" refers to miscellaneous herbaceous plants.

Character of forage and estimated capacity of the western grazing of the United States—Continued

Area	Chief forages	Length of season	Area to support a cow
		Months	*Acres*
New Mexico-Arizona foothills and basins.	Grama, tobosa, galleta, three-awn, Muhlenbergia, and salt grasses, sagebrush, shinnery, and other browse.	4–12	15– 75
San Luis Valley of Colorado.	Blue, salt, and fescue grasses, Baltic rush, and sagebrush.	7– 9	30– 40
Utah foothills and valleys.	Wheat, porcupine, and June grasses, and sagebrush.	5– 7	20– 30
Nevada semideserts	Salt and lyme grasses, greasewood, shadscale, and sagebrush.	1– 4	75–150
Southeastern Oregon and Snake River plains.	Fescue, wheat, and lyme grasses, and sagebrush.	2– 5	50–100
Columbia River Basin.	Blue, fescue, wheat, lyme, and salt grasses, sagebrush, and greasewood.	7– 9	10– 50
Eastern California mountains.	Short, blue, wheat, needle, oat, and brome grasses, deerbrush, and other browse.	3– 6	15– 35
Western Oregon mountains.	Fescue, brome, wheat, pine, and bent grasses, deerbrush, and other browse.	3– 7	30–100
Southwestern California mountains.	Deerbrush and other browse.	6–12	40– 60
California, and southwestern Oregon foothills and valleys.	Browse, "weeds,"[1] annuals including wild oat, rye, brome, barley, and fescue grasses, and bur and wild clovers, and alfilaria.	6– 8	15– 50

[1] On the range "weeds" refers to miscellaneous herbaceous plants.

Variation in carrying capacity.—Vegetable Cover: Most important factor affecting carrying capacity. The amount, palatability, and degree of use possible with maintenance of stand largely determine the basic capacity. Within the Jornada Range Reserve in southern New Mexico, the area of range required to support a cow for a year varies from 20 to over 100 acres, because of the difference in vegetative stand.

Soil: Carrying capacity is influenced by soil both as a result of its productive power and by danger of erosion. The latter is a great factor on watersheds supplying water for irrigation and domestic use in urban centers.

Rainfall and Temperature: Periodic droughts reduce carrying capacity as much as 50 per cent of that of good years. Not only does precipitation influence temperature, but the quantity of precipitation and the time of its occurrence also have an important influence on plant growth and development.

Length of Growing Season: This influences carrying capacity, particularly on meadows and other areas of high moisture content. Under such conditions, two or more times the volume of forage will be produced where the growing season is six months, as compared with three months.

Previous Management: Overgrazing, premature grazing, and other phases of bad management have reduced carrying capacity in specific instances to less than one-fifth of its former capacity, and in other instances even more. Conversely, good methods, particularly deferred grazing, and deferred and rotation grazing, have reestablished badly depleted areas.

Other Factors: Topography, range-destroying rodents, the demand for forage by game, distribution and character of watering places, class of livestock using the range, season of use, methods of handling, distribution of livestock, poisonous plants, other uses of the area, and other local conditions all affect the number of livestock that the range will support at the present time and continue to support in the future.

Improving Grazing Conditions—*General.*—The western range lands include over half of the grazing lands of the United States, but they support only about one-third of the total livestock carried on pasture. This is largely because of the prevailing arid conditions, but also because the range land has been overgrazed and its carrying capacity greatly reduced. Experiments show that these lands can be restored to their original carrying capacity and thus be maintained.

Avoid premature grazing.—Keeping the livestock from the range until the grass has had a chance to get a fair growth will tend to increase the total carrying capacity of the range. On the national forests the prevention of premature grazing has aided in range improvement.

Prevent overgrazing.—When a range is badly overgrazed, the animals do not make sufficient gains in weight to enable them to be marketed at the end of that year. An additional loss results from the lowered carrying capacity of the area grazed. Whether a range is being overgrazed can be determined generally by watching the gradual disappearance of the grasses and their replacement by less desirable vegetation. Recent experiments with range pastures, conducted on the northern Great Plains, composed largely of grama and needle grasses, lead to the conclusion that from 15 to 25 per cent of the foliage covering should remain on this type of pasture at the close of the season, if overgrazing is to be prevented. This conclusion applies also to ranges farther west covered with perennial bunch grasses.

Deferred grazing.—On some types of grasslands, especially in the mountains, the use of deferred-grazing methods has resulted in great improvement. Deferred grazing is withholding the grazing livestock from a range area until the seed crop is mature, or on a range where the forage reproduces vegetatively until it has had a chance to make a full, vigorous growth. This deferred area is then grazed. It may be continued during the subsequent season or for as many seasons thereafter as may be necessary to restore the vegetation and thoroughly establish new plants. Deferred and "deferred and rotation" grazing afford the best opportunity for maintenance of the forage stand and increased carrying capacity. Deferred grazing is accomplished over an entire range under use throughout the whole season by the "deferred and rotation" grazing system. For example, grazing is deferred on successive parts of the range through a series

of years. The range unit is marked off into several numbered divisions. Divisions 1, 2, and 3 are grazed during the first season prior to maturity of the vegetation, but division 4 is not used until the seed has matured. Then the stock is placed on division 4, which is grazed as closely as seems advisable. The following year, divisions 2, 3, and 4 are grazed first, and grazing is deferred on division 1. The third year division 2 is deferred. The fourth year division 3 is deferred, and the fifth year division 4 again.

Rotation grazing.—In the improvement of ranges it is a desirable practice to graze a series of pastures in a regular succession, leaving each year one field for deferred grazing. This method gives the grasses and other forage plants a better chance to reestablish themselves. Under this plan the range is divided into units or "camps" which are occupied in numerical order, 1, 2, 3, and 4, based on the varying capacity, the stock being moved from the last unit—unit 4 in this case—back to 1, again continuing the rotation used during the season. The following year grazing may begin on the same or a new unit and the rotation be followed as before. Usually it is only necessary to defer the grazing on any particular area once in three years in order to maintain the stand of desirable plants. Sometimes the same field should be used for deferred grazing two years in succession.

Grazing with different kinds of stock.—Two or more kinds of animals are often used on the same range, either at the same time or in succession. Sheep prefer the weedy plants that the cattle do not care for and prevent these plants from encroaching on the grasses. Where there is much browse the addition of goats helps to keep the oaks and mesquite from crowding out the grasses.

Improved methods of grazing sheep.—An important step in improvement of the range is open herding and bedding out of sheep. This method is to allow the herd to graze quietly and openly during the day, using dogs as little as possible, turning back the more ambitious leaders, and allowing the sheep to "shade up" in small groups during the heat of the day. At night, instead of being driven in a solid body to some regular bed ground, the sheep are collected on a convenient and suitable bed ground where they happen to be, the herder practically sleeping with them. On some ranges the herder during the day merely rides around the edges of the band, "herding tracks," his pack animals grazing with the sheep. On other ranges the herder stays with the sheep during the day until they are carefully bedded down about sundown, after which he returns on horseback to this permanent camp for the night. The results of open herding show that losses from predatory animals are reduced and that the range is less trampled out. Consequently more stock can be carried, the quantity of wool and mutton produced is greater, and the lambs are heavier. The cost of handling is about the same under either system.

Development of watering places.—An adequate and well-distributed water supply for livestock is important in range management. Without plenty of water within reasonable distance animals can not make satisfactory gains. Reservoirs or tanks for the accumulation of water may be constructed to be used during a portion of the year for supplementing more permanent supplies. In regions where springs and seeps are fairly abundant, they should be protected by fences and the water piped to troughs. Where stock are allowed to collect around small springs, the constant trampling will seriously affect the water supply. In some localities it is necessary to dig or drill

wells and erect pumping plants. Permanent watering places should not be farther apart than 4 or 5 miles in flat or undulating country, 3 miles in rolling country, and one-half to 2 miles on rough ranges. Well-located watering places are helpful in opening up areas that were formerly but little grazed.

Proper distribution of salt.—Proper distribution of cattle from watering places may be accomplished largely by careful location of salt grounds and the attention of riders. Areas that have been too heavily used should be avoided. Salt should be placed at readily accessible spots on ridges, benches, slopes, and in openings in timber and brush, at a reasonable distance from water. Place the cattle at the salt when they are brought on each new piece of range and return them to salt when they stray.

Use of fences.—Fences are valuable for surrounding cattle ranges that are sufficiently high in carrying capacity or for dividing ranges for productive purposes. Drift fenses may also be used in aiding the control or distribution of cattle within the range, in obtaining proper seasonal use of ranges, in deferred and rotation grazing, or for other practices desirable from a forage standpoint. On range of low capacity, fences are expensive and should not be expected to take the place of other means of cattle management. In areas of relatively high forage production, inclosing sheep ranges with coyote-proof fences has increased carrying capacity and resulted in greater production of meat and wool. Fences for cattle should consist of four or five wires on posts set from 16 to 40 feet apart. When posts are set far apart, several stays will be necessary.

Building trails.—On privately controlled ranges, the total carrying capacity may be increased by building trails which will open numerous small areas that are little grazed because of their inaccessibility. Short trails will lessen the distance between feed and water, save the energy of the animals, and prevent trampling of the vegetation. Driveways should be short, follow readily accessible routes, and furnish sufficient feed for the passing stock. Stock bridges across deep canyons and swift, impassable streams, over which both cattle and sheep can cross, have proved worth while.

Introduction of range plants.—Properly chosen introduced plants will greatly increase the carrying capacity of the range lands. In the northeast quarter of the United States the pastures are entirely made up of introduced grasses—bluegrass, white clover, redtop, timothy—all from Europe and all so aggressive that the native vegetation can not compete. In California 80 per cent of the lowland forage is now produced by plants introduced by chance, mainly from the Mediterranean region, such as wild oats, bur clover, wild barleys, alfilaria, and many others. Many of these plants are now spreading in the Columbia River Basin. There is reason to believe that ranges may be improved by the introduction of desirable plants from regions with similar climatic conditions.

Seeding with native grasses.—The original native vegetation tends to reestablish itself if given a fair chance. On range areas where the native grasses have been destroyed by overgrazing, it will take years of good management to restore the original vegetation. Deferred grazing, or allowing the land to remain ungrazed until the seed is ripe, gives most rapid improvement. The animals, particularly sheep and goats, scatter seeds and trample them into the ground. Artificial reseeding with native grasses has not proved satisfactory.

Seeding with cultivated forage plants.—Cultivated grasses and legumes now in use in this country are not adapted to the greater part of the western range country. Tame species have been chosen for culture in humid regions, but not for dry areas. On the more moist lands, such as creek valleys and mountain meadows, the conditions are very favorable for such plants. On the better soils, Kentucky bluegrass, white clover, redtop, and timothy have done well, but the cost of establishment is high. On lands somewhat poorer and less moist, Canada bluegrass, sheep fescue, red fescue, and smooth brome have given promising results.

Regrassing abandoned farm lands.—The great areas of abandoned farm lands are covered with Russian thistle, tumbling mustard, and similar weeds that furnish poor and scanty pasturage. It is a slow process to reestablish such areas in grass under natural conditions. In eastern Colorado it requires 25 years for abandoned farm lands to become fully covered again with native grasses. In other areas the chances are that a far longer time would be necessary, particularly in such areas as southern Idaho.

Dry-Land Forage Crops as Feed for Wintering Range Stock.—In the more favorable locations as regards rainfall in the range States, a large quantity of forage for range animals may be produced if the proper crop is selected.

Sorghums (see 10.47).—In the southern half of the Western States, sorghums, such as sorgo (cane), kafir, milo, feterita, as well as Sudan grass, are most dependable. They are better able to withstand drought than any other staple crops, except cotton. Sorgo is primarily a fodder and silage crop. Sudan grass is useful for hay and pasture, and kafir, milo, and feterita may be utilized as grain, silage, or fodder. In this region forage may be stored in pit and trench silos. Such silos may be easily constructed at several points on the range, and feed thus stored will keep in good condition for several seasons and be available in times of drought.

Small grains (see 10.2).—Corn, wheat, oats, and barley are all grown to a considerable extent in the Western States. Rye is less important. Although these crops are grown primarily for grain, they may be used as hay crops when they fail to make grain, or a small part of the field may be used for hay in good grain years, if other hay is scarce. In the northern part of the Western States corn is preferable to the sorghums as a dry-land forage crop chiefly because it will grow at lower temperatures, and although the acreage of corn is not large and the yield of grain is small, it is used in the support of range livestock, particularly in Montana and eastern Colorado. Small grains are cut for hay more in the Northwest and in California than elsewhere in the West. Oats and barley, even when harvested for grain, are used largely to feed animals, but wheat, unless it is cut for hay, provides little feed for livestock, except in the form of mill waste and straw. The straw left after the small grains are threshed has a low feeding value, and, like cottonseed hulls, can usually be fed most profitably if the cattle are taken to the field where it was produced rather than the straw being transported to the cattle. Straw is valuable in Montana, Washington, and Oregon, where the grain acreage is large. Cattle will maintain themselves on straw with little other feed, if allowed to consume plenty of it.

Cotton (see 10.3).—Growth both as a dry-land and an irrigated crop in New Mexico, Arizona, and California,

and is drought-resistant. The quantity of feed derived from cotton is small, but the cottonseed products—cake, meal, and hulls—are all valuable feeds, particularly the cake and meal, because of their high protein content. The hulls are fed only in the vicinity of the cotton gins, since their low nutritive value makes it uneconomical to ship them any great distance. One pound of cake or meal per day in connection with some coarse roughage will carry an animal through the winter months.

Sunflowers (see 10.491).—Contribute very little in the aggregate to the maintenance of range livestock, but in the North at altitudes where corn does not succeed or only dwarf early varieties can be grown, sunflowers have been grown and utilized successfully as a silage crop. Yields are low, except under irrigation. Both cattle and sheep will eat sunflower silage and thrive on it.

Sweetclover (see 10.427).—A legume that is very uncertain, because of the difficulty that many farmers and ranchers have in obtaining a stand. It is a biennial that reseeds itself, but only those who through experience understand its peculiarities are able to maintain a stand. The white sweet clover is the most popular variety, although the yellow (biennial) is preferred by some, especially in western North Dakota and Montana. A field of sweetclover may perhaps be utilized more effectively by pasturing than by cutting it for hay. There is apparently less danger of bloat in pasturing sweetclover than alfalfa.

Millets (see 10.43).—The foxtail millets, because of their short growing season, are valuable in Montana, Wyoming, and Colorado. They may be cut for hay in 45 to 60 days after seeding, and as the seed is cheap and easy to obtain, millet provides an excellent emergency hay crop in these States.

Native grasses (see 10.418 and .45).—The wild or prairie hays are important aids in carrying range livestock over winter or critical periods. In the northern half of the Western States more or less extensive areas are scattered over the range where ordinarily the native grasses make sufficient growth to be cut for hay. These areas should be fenced or the cattle prevented by other means from pasturing on them until the crop of hay has been harvested. If the season is unfavorable and the rainfall too light to make a hay crop, the reserved areas will provide good fall and winter pasture.

Native range plants.—In the Southwest the yuccas, known as soapweed, Spanish dagger, and beargrass, and the pricklypear, are all useful in periods of emergency. For feeding, the yucca plants are cut off with an ax, their outer cover burned off, and they are hauled to the site of the feeding operations, where they are run through a machine which cuts or shreds them into small pieces. Twenty to twenty-five pounds of this chopped material with 1 or 1½ pounds of cotton seed per day will maintain a poor cow and often produce gains. The pricklypear is utilized by burning the spines off with a blowtorch and allowing cattle to eat the singed plants where they grow on the range. Such feed is more succulent than that obtained from the yuccas, but it has a low feeding value on account of the large percentage of water which it contains. These range plants are all rather slow to renew their growth and should be utilized only in time of emergency.

Root crops (see 10.46 and .6, 12.31).—Root crops, like mangels, carrots, rutabagas, and sugar beets, furnish succulent green feed for winter and come in competition with corn and other silage crops. Corn silage has a higher

feeding value than roots, and where a satisfactory yield of corn can be obtained it ordinarily will be grown in preference to roots. The cost of growing root crops is much more than the cost of growing most silage crops. A large amount of hand labor is required in thinning and hoeing them, and unless the farmer has a family of children or can procure very cheap hand labor the cost of growing any considerable acreage is almost prohibitive. Where the soil continues to be dry for some time after planting, poor germination commonly results. Getting satisfactory stands in the drier parts of the region is an important problem.

Hay from flood plains.—Along the foothills of the mountains and in rough, hilly parts of the ranges are scattered small areas which are well moistened only once or twice a year. These areas are mostly alluvial fans or deltas at the mouths of canyons or arroyos, or lowlands along river courses which occasionally overflow. Such areas should be fenced to produce hay crops and reserve pasturage. In the Southwest they may be seeded to Johnson grass and in the Northwest to western wheatgrass or quack grass. These are all rootstock grasses which will remain dormant for months but spring into rapid growth when moisture is supplied. No reseeding will be necessary when the land is once thoroughly set to any of these grasses. If such areas are thus utilized, as a few ranchmen are already doing, large supplies of hay can be harvested and kept for emergencies.

Irrigated Crops as Feed for Wintering Range Stock.—A large part of the harvested feed in the range States is produced in the irrigated areas, and the buyers of this feed are mainly the ranchmen who control the adjacent lands.

Alfalfa (see 10.421).—Principal forage crop on the irrigated lands and an important dry-land crop in the Northwestern States. The yields of hay are high since several cuttings are obtained each season, varying from two in the Northwest to six in the Southwest. The average yield per acre is about 2 tons. The feeding value of alfalfa hay is high, and it will thus bear reasonable transportation costs.

Clovers (see 10.422 and .423).—Red and alsike clover are grown in a limited way under irrigation in the Northwest, but are grown usually in mixture with timothy. The feeding value of good clover hay is about the same as that of alfalfa but the quality is not so uniformly good.

Tame grasses (see 10.45).—Timothy hay is produced in considerable quantity in the Northwest, and in mixture with clover makes a nutritious feed capable of sustaining animals in good condition even without a grain supplement.

Silage crops (see 10.48).—The principal silage crop in the Southwest is sorghum, which under irrigation will produce from 12 to 16 tons per acre of first-class silage. In the Northwest corn is preferred to sorghum, but at the higher elevations where the season is too short and too cool for corn, sunflowers have been satisfactorily utilized as a silage crop to a limited extent. In certain localities, more especially at high altitudes where low temperatures prevail, mixtures of field peas with oats or some other small grain make an excellent silage. The chief disadvantage with the use of silage on the range is that it must be fed where it is produced. In some cases this necessitates bringing the range animals a considerable distance.

Crop by-products.—Sugar beets are an important crop in irrigated sections, and the by-products of sugar mills

will support a considerable number of range animals. The wet pulp and the beet tops, if the tops are made into silage, must be utilized at or near the factory, but the dry pulp has a feeding value practically equal to that of corn, and can be shipped wherever needed. Cottonseed meal and cake and the products of the cotton gin and oil mills are very nutritious feeds. By-products of the cotton industry are produced in considerable quantity on the irrigated lands of the Southwest.

Pasturage (see 10.45).—Supplemental: The stubble fields after a grain crop has been removed will furnish considerable pasturage for short periods. The straw piles, if left in the field, will help to make up a shortage of range feed. On irrigated lands, alfalfa fields and other hay meadows will support a number of cattle during the winter months. These fields, especially the alfalfa, have a carrying capacity of about two animals per acre for a period of two or three months. Farmers on irrigation projects will usually agree to allow a small number of cattle to graze on their alfalfa fields and hay meadows for a price which makes the sustenance of the animals cost less than if harvested feeds were purchased and transported to the ranch.

Reserves: In many large areas, the production of harvested feeds to supplement the pasturage on the range is not practicable. Where this is the case, the feed sufficient to carry an animal over a period of stress should be provided in reserve pastures. In the West, some of the grasses cure perfectly while standing, and thus provide nutritious feed. It is usually well to divide the range into units, one for summer grazing and the other for winter grazing. The higher mountain areas are suitable only for summer grazing on account of climatic conditions, and if such areas are found on the range, it is well to reserve the lower range for winter pasture.

Relation of Feed to the Number of Animals on a Ranch.—Ranching in the West has been handicapped by the perishing of animals in great numbers during periods of severe drought or of heavy winter snowfall. This condition has been due to a lack of reserve feed, either harvested forage or reserve range. The ranchman should provide feed, either as harvested feed or reserve pasturage, to carry his animals through the periods of range shortage. Such reserve feed insures him against having to sell all his animals at once or lose them by starvation. For the country as a whole, half of the feed of all animals is pasturage and half is harvested forage. Perhaps in no Western State should less than a fourth of the total feed be harvested, or at least reserve pasturage, and in most regions it should be at least a third. Relations of the forage-producing farmer and the ranchmen are intimately correlated throughout the West. The ranchman buys the product of the farmer. The two are the major producers of the community, and the welfare of the one depends largely on that of the other. The economic welfare of the livestock industry in the West depends on the mutual cooperation of the men who range animals and those who produce forage.

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cottonseed meal and cake and the products of the cotton gin and oil mills are very nutritious feeds. By-products of the cotton industry are produced in considerable quantity on the irrigated lands of the Southwest.

Pasturage (see p. 10.45 — Supplemental): The stubble fields after a grain crop has been removed will furnish considerable pasturage for short periods. The straw ... to the fields will help to make up a shortage ... On irrigated lands, alfalfa fields and other ... will support a number of cattle during the winter months. These fields, especially the alfalfa, have a carrying capacity of about two animals per acre for a period of two or three months. Farmers on irrigation ... will usually agree to allow a small number of cattle to graze on their alfalfa fields and hay meadows for a price, which makes the sustenance of the animals cost less than if harvested feeds were purchased and ...

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winter grazing. The higher mountain areas are suitable only for summer grazing on account of climatic ...

... due to a lack of reserve feed, either harvested forage ... range. The rancher should provide ... or harvested feed or reserve pasturage to carry ...

... is harvested forage. Perhaps in ... should, less than a fourth of the total feed ...

... a third. Relations of the ...

12. HORTICULTURE

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.3513 Lima.
.35131 Bush.
.35132 Pole.
.3514 Yard long.
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.3517 Cowpea.
.3519 Miscellaneous.
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HORTICULTURE

GENERAL

The products of American horticulture, including fruits, nuts, and vegetables, but exclusive of ornamentals have an annual valuation of approximately $2,000,000,000. All fruits are valued at $700,000,000, nuts $30,000,000, and all vegetables, including home gardens, $1,270,000,000. The total farm value of all agricultural crops of the country, except timber, may during favorable years reach $12,000,000,000. Thus it appears that the value of horticultural crops is about one-sixth of the total value of all farm crops.

FRUITS

General

Apples, peaches, and pears: Total production and farm price in United States, 1910–1924

Year	Apples[1]		Peaches		Pears	
	Production	Farm price per bushel	Production	Farm price per bushel	Production	Farm price per bushel
	1,000 bush.	*Cents*	*1,000 bush.*	*Cents*	*1,000 bush.*	*Cents*
1910	141, 640	88. 1	48, 171	113. 3	10, 431	100. 9
1911	214, 020	76. 6	34, 880	138. 2	11, 450	109. 3
1912	235, 220	66. 8	52, 343	111. 2	11, 843	100. 4
1913	145, 410	93. 0	39, 707	131. 3	10, 108	111. 2
1914	253, 200	62. 7	54, 109	108. 7	12, 086	93. 7
1915	230, 011	71. 0	64, 097	88. 2	11, 216	82. 5
1916	193, 905	90. 7	37, 505	115. 0	11, 874	104. 8
1917	166, 749	113. 6	48, 765	148. 0	13, 281	127. 4
1918	169, 625	137. 5	33, 094	176. 6	13, 362	161. 1
1919	142, 086	186. 1	53, 178	200. 9	15, 006	185. 7
1920	223, 677	134. 4	45, 620	228. 9	16, 805	194. 1
1921	99, 002	196. 2	32, 602	213. 5	11, 297	172. 2
1922	202, 702	107. 5	55, 852	152. 3	20, 705	139. 7
1923	202, 842	117. 3	45, 382	175. 8	17, 845	165. 5
1924	179, 443	123. 6	51, 679	153. 7	17, 961	165. 4

[1] In recent years the commercial crop has been about one-half o. the total crop.

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Production and value of dried fruits in United States

[Bureau of the Census.

Kind	1899	1909	1919	1921	1923
Apples:					
Pounds	33, 213, 209	44, 568, 244	46, 623, 499	22, 975, 189	19, 397, 844
Value	$1, 906, 642	$3, 098, 095	$6, 772, 080	$2, 799, 891	$1, 692, 815
Apricots:					
Pounds	5, 465, 217	29, 205, 569	24, 192, 628	21, 812, 008	54, 029, 242
Value	$455, 394	$2. 277, 177	$6, 034, 697	$3, 385, 044	$5, 191, 660
Peaches:					
Pounds	5, 662, 390	46, 843, 391	73, 379, 193	35, 406, 706	61, 616, 496
Value	$312, 495	$2, 423, 083	$12, 109, 624	$4, 165, 932	$6, 468, 975
Prunes:					
Pounds	25, 413, 763	138, 498, 490	136, 377, 066	124, 441, 676	245, 086, 104
Value	$970, 927	$5, 130, 412	$18, 253, 691	$10, 097, 515	$22, 352, 088
Raisins:					
Pounds	10, 734, 221	111, 774, 767	293, 300, 581	275, 282, 354	380, 068, 441
Value	$1, 062, 268	$6, 912, 533	$35, 544, 262	$47, 561, 535	$36, 206, 847

Production[1] and value of canned fruits in United States

[Bureau of the Census]

Kind	1899	1909	1919	1921	1923
Apples:					
Cases	----------	1, 205, 742	2, 447, 927	2, 239, 428	2, 726, 498
Value	$1, 125, 119	$1, 898, 720	$9, 081, 598	$7, 747, 923	$6, 539, 951
Apricots:					
Cases	----------	630, 185	3, 939, 768	1, 056, 857	1, 561, 658
Value	$1, 583, 252	$1, 825, 311	$25, 167, 772	$4, 314, 132	$5, 463, 502
Berries:					
Cases	----------	660, 008	2, 347, 213	1, 257, 379	2, 447, 494
Value	$1, 092, 975	$1, 754, 927	$16, 449, 126	$5, 783, 116	$10, 389, 574
Cherries:					
Cases	----------	390, 351	1, 362, 832	779, 602	2, 123, 541
Value	$307, 788	$1, 019, 013	$8, 451, 029	$4, 481, 083	$10, 667, 595
Peaches:					
Cases	----------	1, 467, 213	7, 706, 855	5, 417, 213	7, 039, 334
Value	$4, 283, 165	$3, 753, 698	$46, 516, 225	$23, 865, 076	$26, 262, 022
Pears:					
Cases	----------	637, 782	2, 021, 610	1, 165, 204	1, 817, 924
Value	$2, 188, 201	$1, 833, 214	$14, 202, 963	$7, 538, 673	$9, 389, 978

[1] 24 cans to the case.

Location.—The location of an orchard or small-fruit planting is its particular position in relation to the surrounding country. In the selection of a location the following points should be carefully considered: (1) Is the soil adapted to the kind of fruit to be planted? (2) Is the climate favorable, not too cold in winter or unduly subject to late frosts in the spring or right after blossom time? (3) Is the ground flat and likely to hold cold air,

or is it rolling and sloping enough to let the cold air drain off? (4) Is the ground too rocky or too steep for cultivation? (5) Is a body of water close by to modify the climate and to be used in transporting fruit to market? (6) Is there an available and convenient water supply for spraying purposes? (7) Is there a comparatively short haul to a shipping point or market? (8) Is there a near-by railroad making a fairly direct route to good fruit markets? (9) Are there good roads in the community? (10) Are other orchards near by, since buyers are attracted to productive communities? (11) Is a cooperative marketing association in operation in the community or country?

Site.—The site of an orchard is the particular piece of ground upon which the trees, bushes, or plants are to be set out. Some of the factors of location are also factors of site. The direction of the slope of the site is immaterial, if it is not too steep. Fruit from trees planted on a steep southern slope is earlier than that from a steep northern slope. A windbreak may be desirable, but on the other hand it may be a detriment if it is located on the north side, where it tends to form a warm pocket hastening blossom time. A late frost may kill the blossoms, when unopened buds would not be injured. An elevation or slope is better than a flat surface because of air drainage, but there should be no low places where cold air will settle and not drain off. The site should be convenient to the packing house, to the main road, and to the water supply. Soil should be adapted to the kind of fruit to be grown.

Pome Fruits

Apple—*General.*—Apple growing in the United States dates from the early settlement of the country, and many of our best varieties are chance seedlings from Old World stock. As water and rail transportation improved the industry grew. The tremendous commercial expansion during the last 35 years was caused by the development of fast freight lines, refrigerator cars, water-transportation refrigeration, and cold-storage plants. Formerly apples were seasonal, but now they are an all-year crop. The big commercial sections for winter varieties are the Hudson River region of New York, western New York, the Shenandoah and Cumberland Valleys, southwestern Michigan, the Wenatchee and Yakima sections of Washington, the Hood River region of Oregon, the western slope of Colorado, and the Watsonville section of California. The main commercial sections for summer apples are in Delaware, the Eastern Shore of Maryland, New Jersey, southern Indiana, southern Illinois, and California. For home use the apple is grown in every section of the country that has a temperate climate, but it can not stand extreme heat and cold. A few apples are grown on higher elevations of the Gulf States, except in Florida. Practically no apples are grown in large areas of the Great Plains, in the high and cold mountain sections of the West, or in the low, hot portions of Arizona and California.

Commercial varieties.—The following commercial varieties, as recommended by extension and State horticulturists, are given by groups of States which have similar natural conditions of climate and soil:

Group 1 (Maine, Vermont, New Hampshire, Connecticut, Massachusetts, and New York): McIntosh, Baldwin, Wealthy, and Delicious for all States; Northern Spy for all but Connecticut and Massachusetts; Wagener for all

but Maine and Vermont; Gravenstein for all but Vermont and New York; Oldenburg for Massachusetts and Connecticut; Rhode Island Greening for Maine, Vermont, and New York; Tompkins King, Opalescent, Rome Beauty, and Twenty Ounce for New York; and Northwestern Greening, Tolman Sweet, Fameuse, and Winter Banana for Vermont.

Group 2 (Pennsylvania, western Maryland, West Virginia, and Ohio): Stayman Winesap, Delicious, Grimes Golden, and Jonathan for all States; Oldenburg and Yellow Transparent for all but Pennsylvania; Rome Beauty, Baldwin, and Northern Spy for all but western Maryland; York Imperial for West Virginia and Pennsylvania, but doubtful in western Maryland: Wealthy for West Virginia and Ohio; Rhode Island Greening for West Virginia and Ohio; Smokehouse, McIntosh, and Stark for Pennsylvania; Black Ben and Hubbardston for West Virginia; Winter Banana, Golden Delicious, Gallia Beauty, Red Rome, Maiden Blush, and Ensee for Ohio; and Williams for western Maryland.

Group 3 (Delaware, New Jersey, Virginia, and eastern Maryland): Yellow Transparent, Oldenburg, Grimes Golden, Jonathan, Delicious, and Stayman Winesap for all States; Rome Beauty and Paragon for all except eastern Maryland; Williams, York Imperial, and Winesap for Delaware; Starr, Wealthy, McIntosh, and Stark for New Jersey; King David, Virginia Beauty, Yellow Newtown, Winesap, York Imperial, and Ben Davis for Virginia; and Williams for eastern Maryland.

Group 4 (North Carolina, South Carolina, Georgia, Tennessee, and Kentucky): Delicious, Stayman Winesap, and Winesap for all States; Rome Beauty for all but South Carolina and Tennessee; Paragon or Arkansas (Mammoth Black Twig) for all but Tennessee and Kentucky; Yellow Transparent for all but North Carolina and Georgia; Grimes Golden for Tennessee and Kentucky; Early Harvest for South Carolina and Tennessee; Yates for South Carolina and Georgia; King David for Kentucky; Oldenburg and York Imperial for Tennessee; Red June, Williams, and Bonum for North Carolina; Wilson Red June for South Carolina; and Arkansas Black, Ben Davis, Kinnard, and Terry for Georgia.

Group 5 (Indiana, Illinois, and Lower Peninsula of Michigan): Jonathan and Grimes Golden for all States; Wealthy for Illinois and Michigan; Rome Beauty, Stayman Winesap, Oldenburg, Yellow Transparent, Delicious, and Winesap for Illinois and Indiana; Chenango, Benoni, Maiden Blush, Salome, Winesap, Ben Davis, Willowtwig, and York Imperial for Illinois; and Fameuse, Wagener, McIntosh, Red Canada, Rhode Island Greening, and Northern Spy for Michigan. For the Upper Peninsula of Michigan: Wealthy, McIntosh, Northwestern Greening, and Wolf River.

Group 6 (Kansas, Missouri, Oklahoma, and Arkansas): Winesap, Jonathan, Grimes Golden, Stayman Winesap, and Yellow Transparent for all States; York Imperial and Wealthy for Kansas and Missouri; Delicious for Kansas, Missouri, and Arkansas; Rome Beauty, Gano, and Oldenburg for Missouri; and Collins, Ben Davis, Maiden Blush, Williams, Lowland Raspberry, and Early Harvest for Arkansas.

Group 7 (Minnesota, Wisconsin, and northern Iowa): Wealthy and Northwestern Greening for all States; Brilliant and Tolman Sweet for northern Iowa; Oldenburg for northern Iowa and Minnesota; McIntosh and Fameuse for Wisconsin; Anisim and Patten, and in favored locations McIntosh, for Minnesota; and De-

licious in a narrow area in southeastern Minnesota and in some sections of Wisconsin.

Group 8 (Nebraska, central Iowa, and southern Iowa): Oldenburg, Jonathan, and Grimes Golden for all sections; Wealthy for Nebraska and central Iowa; Winesap and Delicious for Nebraska and southern Iowa; Northwestern Greening for central and southern Iowa; Fameuse for central Iowa; Gano, Black Ben, and Willowtwig for southern Iowa; and Stayman Winesap, Virginia Beauty, and York Imperial for Missouri and Nebraska.

Group 9 (Utah, Colorado, and New Mexico): Delicious, Gano, Jonathan, Rome Beauty, and Winter Banana are first choice, and Stayman Winesap, Paragon, Arkansas Black, Grimes Golden, Rhode Island Greening, and Northwestern Greening are second choice for Utah; Jonathan and Rome Beauty are first choice, and Delicious, Grimes Golden, and Winesap or Stayman Winesap are second choice for Colorado; Stayman Winesap, Delicious, Jonathan, and Wilson Red June for all altitudes in New Mexico, Arkansas Black for low altitudes; and Rome Beauty, White Pearmain, and McIntosh for high altitudes in New Mexico.

Group 10 (Washington, Oregon, and Idaho): Winesap, Delicious, and Winter Banana are first choice, and Jonathan, Esopus Spitzenburg, Rome Beauty, Stayman Winesap, Black Ben, and Yellow Newtown are second choice for Washington; Winesap, Jonathan, Rome Beauty, and Delicious are first choice for Oregon and Idaho, and Paragon is added for Idaho; Arkansas Black, Stayman Winesap, Paragon, and Winter Banana are second choice for Oregon; Yellow Newtown is the first choice for the Hood River Valley in Oregon, and Esopus Spitzenburg, Arkansas Black, Delicious, Gravenstein, and Ortley are second choice.

Group 11 (California): Red Astrachan, Gravenstein, Yellow Bellflower, Yellow Newtown, Delicious, White Pearmain, and Winter Banana for the coast and coastal valleys; and Yellow Transparent, Red Astrachan, White Astrachan, Gravenstein, Rome Beauty, Jonathan, Delicious, Winesap, Stayman Winesap, Esopus Spitzenburg, Arkansas Black, Grimes Golden, Gano, and Baldwin for the foothill and mountain sections.

Group 12 (Western Montana): McIntosh, Delicious, and Wealthy are recommended.

Propagation.—To propagate by grafting, use seedling stock or roots that have made one season's growth from the seed. Cut the roots into pieces about 3 inches long, and graft the cions of the desired sort by the whip-graft method. Wrap the grafts with waxed cord, and store in moist sand to callus. In the spring plant 6 or 8 inches apart in nursery rows about 5 feet apart and grow for one or two years. When whole seedling roots instead of piece roots are used for making root grafts, the graft union is made at or near the crown of the seedling stock.

To propagate by budding, line out the seedling stocks in the nursery in the spring, grow there until July or August, and then bud at a point 2 inches above the surface of the ground by means of the shield-bud method. The buds that are inserted on the stocks during the summer remain dormant until the following spring.

Apple seedlings are grown from crab-apple seeds, from ordinary apple seeds from the cider mills, or from "French crab" seed imported from France. The seeds are planted about 1 inch apart in rows 18 inches apart.

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The seed-bed soil should be made rich with manure or fertilizer.

Planting.—Well-grown, healthy 1-year-old budded nursery trees with good root systems seem to be preferred over 2-year-old trees, although many fruit growers still plant 2-year-old trees, except of peach. "June buds" of peach are also desirable. If trees more than 2 years old are used they should always be dug and moved with a large ball of earth on the roots and have the tops cut back severely. In the colder sections of the country trees should be planted in the early spring. In the warmer sections they may be planted in late fall or early spring.

Distance apart.—On rich soil or soil that can be made at least fairly rich set permanent apple trees 40 feet apart each way. This will require 27 trees to the acre. If thin soils, sandy or rocky, must be used and will not support more than medium growth, set trees 30 to 35 feet apart.

Filler trees.—Set one tree between each two permanent trees in the row and a filler row between each two permanent rows, if filler trees are to be used to occupy the ground while the permanent trees are small. If this plan is followed, the trees will be 20 feet apart each way. Take out the filler trees when they begin to crowd the permanent ones. Filler trees may be apple, pear, or peach, but the apple is best.

Taking out filler trees.—Begin at one corner of the orchard and leave the corner tree, but take out the two trees next to the corner tree, since these two form a short diagonal row. Leave the three trees nearest to the two taken out, since they form the next diagonal row. The next diagonal row to this one has four trees, so take all of them out. The next diagonal row has five trees, so leave them all in. Take out the next diagonal row of six trees. In this manner take out all the trees in every other diagonal row throughout the orchard. One-half of the trees will then be taken out and one-half left, part of which still are filler trees. In the center of each square formed by any four permanent trees one filler tree will be found, which may be left a few years until it begins to crowd the permanent trees; then it should be taken out, leaving only the original permanent trees.

Pruning.—When planting, if the tree is an unbranched stem or whip, cut off the top about 30 to 36 inches above the ground. If the tree has branches, select five or six arranged around the trunk, but at different heights above the ground. Prune these back to about 6 inches and cut off all other branches right up to the trunk. These are the foundation limbs. Cut off the central shoot or leader about 30 to 36 inches above the ground. At the end of the first year's growth cut off one-third to one-half of the new growth of each foundation branch and the central leader. At the end of second and third year's growth cut back the leader of each foundation branch about one-third of the new growth. Do not trim off the new side shoots. For the fourth and following years thin out the crowding branches, but do not cut back unless they make the trees appear ragged or unsymmetrical. Trees will grow rather tall at first, but when they begin to bear, the weight of the fruit will pull the limbs down. Succeeding crops pull the limbs down lower, until in time they ride on the ground. In the meantime water sprouts have grown along the bending limb. Select the best one or two on each limb near the center of the tree and cut out the rest. When these shoots begin bearing they bend over and soon crowd those below; then cut out the lower ones.

Thinning.—Thin the fruit by hand picking. Take off all wormy and misshapen specimens and leave only enough

of the best well-distributed fruits to average from 6 to 8 inches apart when ripe. Leave only one fruit to a cluster if clusters are abundant; otherwise leave two which will not touch each other. Do the thinning immediately after the "June drop."

Weight of bushel of apples

State	Weight	State	Weight
	Pounds		*Pounds*
Arkansas	50	New York	48
Connecticut	48	North Carolina	48
Florida	48	North Dakota	50
Iowa	48	Ohio	50
Kansas	48	Oregon	45
Maine	44	Tennessee	50
Massachusetts	48	Texas	50
Michigan	48	Vermont	46
Minnesota	50	Virginia	45
Missouri	48	Washington	45
Nebraska	48	Wisconsin	48
New Jersey	50		

Size of standard apple box is 18 by 11½ by 10½ inches, inside measurement.

Size of special apple box is 20 by 11 by 10 inches, inside measurement.

Size of standard 3-bushel apple barrel: Head, 17⅛ inches in diameter; stave, 28½ inches long; bulge, 64 inches in circumference.

Crabs.—Crabs are propagated and handled like apples in all respects. However, since the trees are usually smaller, they may be planted 25 or 30 feet apart each way.

Pear—*General.*—The leading States in commercial production are California, Washington, Oregon, New York, Michigan, New Jersey, Colorado, Missouri, Texas, Ohio, Indiana, Illinois, Maryland, and Delaware. For home use the pear is about as widespread as the apple.

Varieties.—Good commercial varieties are Bartlett, Bosc, Anjou, Nelis, Seckel, Sheldon, and Clapp Favorite in the East, and Comice, Bartlett, Bosc, and Nelis in the West. Kieffer is extensively grown in New Jersey, Maryland, and southward, and Le Conte in the far South.

Production.—The pear needs the same kind of soil and general care of planting, pruning, spraying, cultivating, and fertilizing as the apple, with the exception that the trees should not be forced into very rapid growth on account of the danger of injury by fire blight. If the blight is cut out regularly just as soon as it appears, a vigorous tree growth can be maintained. When blight accompanies vigorous growth, cultivating and fertilizing should be stopped for two years or more, and grass seed sown to form a sod. Let the sod remain until the trees need to be stimulated into vigorous growth. This may be done by application of nitrate of soda or sulphate of ammonia, 3 to 8 pounds per tree, depending on the size, broadcast on the sod; by manure spread on the sod; or by cultivation and fertilizer and manure. In general

pears succeed where apples do, the exceptions being that pears are not quite so hardy as the hardiest apples, and that the oriental varieties succeed in the hot climate of the South where apples do not grow.

Thinning.—Thin the fruit soon after the "June drop," taking off all inferior fruit, breaking up the clusters, and leaving pears 4 to 6 inches apart.

Distance apart.—Set standard pear trees 20 to 30 feet apart each way. Filler trees are not often used, but may be for a few years, as described under apples, if the pear trees are 30 feet apart each way.

Dwarfs.—Dwarf pear trees are planted mostly in home orchards and suburban fruit gardens, but sometimes are used for small commercial orchards. Dwarf trees are propagated by budding upon quince stocks, using the Angiers quince, which is best for the purpose. They are generally productive and come into bearing early. Good varieties on dwarf stocks are Bartlett, Angouleme, Seckel, Clapp, Bosc, Anjou, Nelis, Barseck, and Sheldon. Dwarfs are planted 12 to 14 feet apart each way.

Quince.—Not grown commercially to any great extent. Propagated like the apple. Since the trees blight seriously, they should not be forced into rapid growth. Needs practically the same treatment as pear. Good varieties are Orange, Meech, Rea, and Van Deman. Set the trees 12 to 14 feet apart each way.

Stone Fruits

Apricots—*Propagation.*—Usually budded on apricot or peach stocks, and on Marianna plum for growing on heavy ground. Seedlings are grown like peach seedlings. In all respects except pruning and fruit thinning the directions given for peach growing will apply to the apricot.

Pruning.—Fruit buds develop on one-year shoots and on spurs on older wood. The fruit spurs live about three years, hence they must be constantly renewed. Good growth is necessary each year, from 10 to 30 inches on the old trees and a few inches less on young trees. Thin out crowding branches, and when necessary to head back to make room for new growth, cut to lateral branches. If branches become long and willowy cut them back. If trees do not make enough growth cut them back severely about every third year to induce vigor. If spurs and shoots are attacked by brown rot cut them out.

Thinning.—After the "June drop" thin the fruits so that they will average about 2 inches apart when ripe. If more than one fruit is left on a spur, save those on opposite sides.

Cherry—*General.*—The commercial sour-cherry sections are along the Hudson River and in western New York, central and western Michigan, and the Sturgeon Bay section of Wisconsin. The commercial sweet-cherry sections are in Idaho, Washington, Oregon, and California, and the same as the sour-cherry sections in New York and Michigan. Cherries require about the same climatic and soil conditions as apples, and are about as widespread for home use.

Sour cherry.—Propagated by budding on mahaleb roots. Nursery trees 1 or 2 years old are used for orchard planting. Cut off bruised and broken roots, and prune the rest to about 6 inches. Cut the top off about 2 feet from the ground. If there are side branches, cut them back to 3 or 4 inches. Prune the same as for peach trees. Maintain an annual growth of about a foot, since twigs which grow one year produce fruit or fruit spurs the next year. Cutting back the leading shoots thins out

the tops and keeps them low. Set out trees 20 feet apart each way.

Sweet cherry.—Propagated by budding on mazzard roots. One-year-old nursery trees are best for planting. Prune the roots to about 6 inches in length and the top to about 36 inches. Set out trees 20 to 30 feet apart each way. Only a small amount of pruning is necessary, except thinning out of crowding branches each year and heading back an occasional branch if it makes the tree unsymmetrical.

Cultivation.—Requires about the same cultivation, care, and fertilizing as peach trees. Since sweet-cherry trunks often are injured on the southwest side by sudden freezing and thawing in winter, it is well to shade that side of the trunk in winter with a board, a veneer, or some other kind of trunk protector.

Pollination.—Sweet-cherry blossoms of any variety are not likely to fertilize one another. Varieties like Napoleon, Bing, and Lambert do not cross-fertilize to any great extent. Usually Long Stem Waterhouse and Black Tartarian will fertilize the blossoms of Napoleon, Bing, Lambert, and other varieties. It is best to plant several varieties fairly well mixed together in the orchard.

Nectarine.—Handle like the peach in all respects.

Peach—*General.*—The principal commercial peach sections are central and south-central Georgia; the sandhill sections of North Carolina and South Carolina; Delaware; Eastern Shore of Maryland; New Jersey; Hudson River section of New York; western New York; Cumberland Valley of Pennsylvania, Maryland, and West Virginia; northern Ohio; western Michigan; southern Indiana; the Ozark region; eastern Texas; western Colorado; and central California. Commercial peach production exists in about three-fourths of the States, with some home plantings in most of the others.

Climate.—Peaches endure more summer heat but less winter cold than apples. A winter temperature of −13° F. is about all the fruit buds can stand. The trees usually will live through −20° to −25° F., but will fruit only after a mild winter in such cold regions.

Soils.—Peaches succeed on any soil that will produce apples. Coarse, leachy sand is not desirable, but fine sandy loam over clay subsoil is especially good. Depleted soils are readily built up by use of cover crops, manure, and fertilizers. The soil should be deep enough to provide abundant anchorage and feeding space for the root system.

Varieties.—Selection depends upon whether the crop is for local or distant market, canning, or drying. The extension horticulturist in each State should be called upon for advice as to the varieties to grow.

Propagation.—Propagation is by budding on seedling peaches, plums, or almonds. It is done largely during July and August, but sometimes extends into September. The seeds are planted in nursery rows either in the fall or in the spring, and budding is done the same year.

Planting.—Use 1-year-old nursery trees only. Prune the roots to about 6 inches in length and cut off all bruised or broken ends. Prune the top to a whip and cut it off 18 to 24 inches from the ground. Set out trees 20 feet apart each way. On very strong ground set out 22 to 24 feet apart each way.

Pruning.—At the end of the first year's growth save from three to six branches well distributed around the trunk for the main branches, and cut them back about one-third. Make the cut just above the side branch, and do not take off any side branches unless they are

crowding. For the second and third years' growth cut back the center shoot of each main branch about one-third and take out any crowding side branches. For the fourth and later years' growth cut back the leading shoots far enough to keep the heads low, take out dead or crowding limbs and thin out where necessary.

Thinning.—After the "June drop" take off all wormy and defective fruits, and leave only enough well-distributed good fruits to average about 6 or 8 inches apart over the bearing surface when ripe. Some fruits will be closer together than 6 inches, but they should not touch one another.

Orchard care.—Clean cultivation, followed by an early fall cover crop, is best for peaches. The cover crop should be plowed under early in the spring and the ground kept cultivated until time to sow cover-crop seed in the fall. The trees will not thrive in sod. If the trees are not vigorous, use about 3 pounds of nitrate of soda or sulphate of ammonia per tree for trees 4 or 5 years old in bearing. Use less for younger trees, and up to 6 pounds for large bearing trees. Apply broadcast early in the spring when the buds begin to swell.

Plum—*General.*—There are three kinds of plum, American, European, and Japanese. The American plums are mostly very hardy, and the fruit is of small to medium size with soft to firm flesh. For home use and in a small way commercially they succeed over the entire eastern United States, both North and South. One species native to the Great Plains area is the only hardy one in this section, and has been crossed with the European and Japanese varieties, resulting in large, hardy seedlings of good quality. The European group contains the very large red, yellow, and blue varieties having firm, sweet flesh, used in the fruit-stand trade. They are grown commercially in the Hudson River and lake regions of New York, in western Michigan, California, Oregon, Washington, and Idaho. Prunes belong to this group, and are grown in the last four States mentioned. For home use this group succeeds where apples do, except where the hardiest apples are required. The Japanese varieties, mostly large, red and yellow, and pointed, are grown commercially in California and to a small extent in the Gulf States. They are sometimes sold at fruit stands. For home use they will grow in almost any place where apples and pears succeed, provided they are sprayed thoroughly to control brown rot.

Varieties.—The selection of varieties depends upon the location and purpose, and the advice of the State extension horticulturist should be followed in this respect.

Propagation.—Usually budded on myrobalan plum, peach, or almond stocks, and at times on Marianna plum and apricot stocks.

Planting.—Use nursery trees, 1 or 2 years old, preferably 1 year old. Set out 18 to 20 feet apart each way. Prune the roots to about 6 inches in length. Plant the tree an inch or two deeper than it stood in the nursery. If the top is an unbranched shoot, cut it off 24 or 36 inches from the ground. Let from three to six buds grow to form the main branches. If there are side branches cut them to 4 to 6 inches, and the top to 30 to 36 inches from the ground.

Pruning.—For three years cut back these main branches about one-third of their annual growth and thin out any crowding twig growth. After that simply cut out crowding limbs and twigs. Do not cut back the main shoots unless one or more grow too rapidly and throw the top out of balance.

Thinning.—Thin out the fruits of a cluster so that they will not touch one another. Take off enough fruits so that those left when ripe will be at least 2 inches apart. Do this after the "June drop."

Small Fruits

Blackberry—*General.*—Blackberries are hardy, but do not stand very hot weather. They are grown principally in the Pacific Coast States and east of the Great Plains area, except in Florida and in the southern parts of the Gulf and South Atlantic States.

Varieties.—In southern California the Texas Early (Crandall) is the leading variety, and in the central and northern parts of that State the Lawton is an important variety for commercial purposes; for home use and local markets the Mammoth and Himalaya are grown throughout the State. In Oregon and Washington the Evergreen is the important variety. In the North Central States the Eldorado, Snyder, and Mersereau are among the best sorts. In Kentucky and Tennessee the Early Harvest and Eldorado do best. In southern Missouri and Arkansas the Early Harvest and McDonald are productive. In Texas the Dallas, McDonald, Haupt, and Lawton varieties are desirable. In New Jersey the Ward, Joy, and Evergreen are recommended. In the other Eastern States the Eldorado and Snyder are widely grown.

Propagation.—Propagated by suckers from the roots, but it will occasionally tip root like black and purple raspberries. The blackberry succeeds on any fairly good soil, but prefers sandy loam. New plantings are made in rows 6 or more feet apart, with plants 2 feet apart in the row. The cultivating, fertilizing, pruning, trellising, and winter protection are the same as for black and purple raspberries.

Dewberry—*General.*—The dewberry, called also "trailing blackberry," is extensively grown in a few localities in North Carolina, Michigan, New York, and New Jersey, where, because of the skill of the growers in using special methods of training and culture, it is very profitable.

Varieties.—Very few varieties of dewberry are widely grown in the United States, the Lucretia being the leading variety, except in the Gulf Coast States. In Texas the Mayes is the leading variety, but in the other Gulf Coast States very few dewberries of any kind are grown. In California the Gardena is raised to a considerable extent. The Young, a new variety, has shown good results.

Soils.—Coarse sandy loams having a clay subsoil are the leading soil types in three of the principal dewberry sections. Any fertile soil provided with good drainage and yet having a good supply of humus to retain moisture is suitable for growing dewberries.

Propagation.—Propagated by tip rooting, like the black raspberry, since the dewberry has trailing shoots or canes.

Planting.—Usually set during the winter and early spring in the South and in early spring in the North. Fall planting is seldom practiced. The hill system of training is commonly used in North Carolina, and the plants usually are set 5 feet apart each way. If the canes are to be trained in solid rows, the plants usually are set in New Jersey 3 feet apart in rows which are 4 to 6 feet apart, and in Michigan 2½ feet apart in rows 7 feet apart. In the Germantown section of New York they are set 2 feet by 7 or 8 feet apart. Dewberries need the same cultivating and fertilizing as raspberries.

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Training.—In garden or field culture the canes usually are supported by stakes or on trellises. During the first year after planting allow the shoots to trail the ground. If stakes are to be used, set one at each plant the next spring and wind the canes spirally around it, tying with soft string in two or three places. If a wire trellis is used, which consists of a row of posts with one or two wires stapled to it, set the posts 20 to 40 feet apart, depending on their strength and the vigor of the canes. If two wires are used, place them 3 and 5 feet above the ground. If a single wire is used, place it from 2½ to 5 feet above the ground. Bunch the canes of each plant and tie them to the wires, then cut off the ends a few inches above the top wire.

Pruning.—In the warmer sections plants are pruned immediately after fruiting by the cutting or mowing off of all new and old canes. Burn them, to kill the insects and disease that may be on them. Cultivation follows, and a rapid growth of new canes is made. Leave them on the ground over winter, and in the spring tie to stakes or trellises. In the northern limit of dewberry culture cut out and burn the fruiting canes as soon as the crop is gathered. Leave the new shoots on the ground over winter, protect with straw or other material if necessary, and tie them to the stakes or wires in the spring.

Logan Blackberry—*General.*—The Logan blackberry, formerly thought to be a hybrid between a blackberry and a red raspberry, is now considered a variety of the Pacific coast species of trailing blackberry. It is adapted to the milder climates of California, Oregon, and Washington, where the temperature does not reach 0° F., but so far as known it does not succeed in any place east of the Cascade and Sierra Ranges. Although the plants may survive in some sections of the South, they do not fruit well, and they are not hardy in the Northern States.

Production.—Practically the same recommendations as for dewberries.

Currant—*General.*—Currants will stand very cold weather, but not long, hot summers. They succeed in the northern two-thirds of the United States, provided they are irrigated in the arid sections of the West and protected by windbreaks in the Great Plains area. Do not plant currants where white pine trees are being grown, since the blister-rust disease, which kills the white pine tree, spends part of its life on currant and gooseberry bushes.

Propagation.—Propagated by cuttings 8 to 10 inches in length, made in the fall, winter, or spring. If made in the spring they should be placed at once about 4 inches apart in a nursery row. If made in the fall or winter they should be stored bottom end up in damp sand in a cool place, and set in the nursery row in the spring.

Planting.—Use nursery plants 1 or 2 years old for new plantings. Prune off broken or bruised roots; cut the rest back to 8 or 10 inches and the top to about 6 inches. Place the rows 6 to 8 feet apart and the plants 5 to 6 feet apart in the rows.

Pruning.—Thin out old or crowding shoots and cut back those that grow too long.

Production.—Cultivation and fertilizers given for raspberries will apply to this crop. Currants require cool and rather heavy, well-drained soil. They do not succeed in hot climates.

Gooseberry—*General.*—The gooseberry has about the same climatic limitations as the currant, but will stand somewhat more summer heat and can be grown a little farther south. Like the currant, it needs irrigation and

winter protection in dry and cold sections. Do not plant gooseberries where white-pine trees are growing or will be planted, since the blister-rust disease of gooseberries will kill the white pines.

Propagation.—Propagate by cuttings like the currant, and also by mound-layering. To do mound-layering, cut off the entire top in the spring and let new shoots grow. In July mound up the earth around these shoots halfway to the tips. The shoots will be rooted by the following spring. Take them off and plant in nursery rows for one or two years, then use for new plantings.

Production.—The gooseberry will grow where the currant does and requires the same care in all respects.

Raspberry—*General.*—Raspberries can not stand as much heat as blackberries, so are not grown to any great extent in the southern third of the United States. They need winter protection in the Great Plains area and adjoining cold regions. The principal commercial sections are Sebastopol, Calif.; Puyallup Valley, Wash.; Wathena, Kans.; western Michigan; western Maryland; southern New Jersey; Hudson River Valley; and western New York.

Propagation.—There are three types of raspberries, namely, red (including yellow varieties), black, and purple. The black and purple varieties are propagated by tip-rooting and the red varieties by suckers or shoots from the roots. New plants should be taken only from patches free from disease.

Planting.—Sandy loams are preferable, but almost any loamy soil will grow raspberries. Set out the young plants 2 or 3 feet apart in rows 6 to 8 feet apart. Cut off all the canes on new plants when they are set to remove any possible disease. New shoots will start from buds on the crown of the root system.

Pruning.—When the new shoots of the black and purple varieties are from 2 to 3 feet high, or whatever height is desired, pinch out the growing tip to cause the shoots to branch. The following spring cut the side branches of the purple varieties to a length of 6 to 18 inches, and the top to about 4 feet. Cut the side branches of blackcaps to four or six buds and the tops to 3 or 4 feet. The red varieties usually do not branch to any great extent, so in the spring cut off only the dead tips, leaving the canes about 4 feet in height. As soon as the crop of fruit is gathered cut out and burn all the fruiting canes. Take out all weak shoots, leaving only the strong new shoots for producing the next year's crop. Do not pinch out the growing tips of new canes of fall-bearing or ever-bearing red varieties, since these tips later produce the fall crop.

Staking or trellising.—If raspberry canes need supporting, use stakes or trellises. Blackcap raspberries, properly pruned, should require no supporting. When they are grown in hills, a stake at each hill with the canes tied to it is sufficient. A trellis will support either hills or matted rows. If a single wire trellis is used the canes are tied to the wire. A better trellis is made by nailing a crosspiece about 18 inches long on each post and running a wire lengthwise of the row along each end of the crosspieces. Keep the canes between these two wires. The posts of the trellis should be set from 15 to 20 feet apart and the wires placed 2½ to 4 feet above the ground. In the Pacific Coast States, where red raspberries grow up to 15 feet high, the canes are woven on wire trellises about 4 feet high.

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Winter protection.—In very cold sections, where the canes need winter protection, they may be bent over in the late fall and covered with straw or similar material. Another method is to bend the plants down lengthwise of the row and plow a furrow over them along each side of the row, then level the earth with a hoe or rake. In the spring straighten up the canes.

Cultivation.—Give clean cultivation throughout the season, or clean cultivation followed by a cover crop in August or later. If a cover crop is used plow under early in the spring, and cultivate until time to sow cover-crop seed again. A rye cover crop will cause much trouble if not plowed under early.

Fertilizers.—Stable manure, at the rate of 10 tons per acre, is recommended if the soil needs enriching. If the plants need stimulating use from 100 to 200 pounds of nitrate of soda per acre, spread broadcast early in the spring.

Strawberry—*General.*—Strawberries are grown for home use in every State in the Union, and commercially in at least half of them. In 1923 the rail shipments amounted to 17,804 cars, and 20 States shipped more than 100 cars each. Tennessee shipped 3,279 cars, Maryland 1,916, Louisiana 1,678, North Carolina 1,668, Arkansas 1,342, Virginia 1,193, Florida 1,038, and Delaware 924 cars. Shipments are made from Florida and Texas in January and February, from Louisiana and Alabama in March, from North Carolina, Tennessee, and Arkansas in April, from Missouri, Virginia, Maryland, Delaware, and New Jersey in May, and from New York, Massachusetts, and Michigan in June.

Soils.—May be grown upon almost any type of soil, from coarse sand to heavy clay, provided it is well supplied with moisture and at the same time well drained. A rich soil is most desirable.

Varieties.—The variety problem is a complicated one, and although new varieties should be tried, only those that are proving to be best in any section should be planted commercially. Follow the advice of the State extension horticulturist in the choice of varieties.

Propagation.—Propagated by new plants, which form on runners of established plants.

Planting.—Set out plants 18 inches apart in rows 3 to 4 feet apart for matted-row culture, or 12 inches apart in rows 18 to 30 inches apart for hill culture. Double rows 12 inches apart often are used for hill culture, and at least an 18-inch space left between the sets of double rows. Early spring planting is recommended, so that the plants may get a start while the ground contains plenty of moisture.

Blossoms.—Since some varieties have perfect or staminate blossoms and others have imperfect or pistillate ones, it is absolutely necessary to have about every third row planted with a staminate variety in order to get a good set of fruit. Imperfect blossoms alone will not set fruit.

Cultivation.—Clean cultivation is necessary throughout the first season for best results. If the plants are mulched for winter protection, the mulch takes the place of cultivation the following spring. In hill culture cut off all runners and force the plants into a heavy growth. In matted-row culture save enough new runner plants, and cut off the rest as they appear. Keep blossoms picked off, except on ever-bearing varieties, after June.

Fertilizer.—The best fertilizer for strawberries is 10 to 20 tons of stable manure. In the absence of manure, if the land is not fairly rich use 200 pounds of steamed ground bone and 100 pounds of nitrate of soda per acre.

Make three applications, the first in the spring and the others at intervals of about a month. This is to be done the first year the plants are set. During the next spring 100 pounds of nitrate of soda scattered along the rows as soon as the fruits are set will increase the crop and improve the vigor of the plants.

Winter mulching.—Strawberry plants are heaved out of the ground by the alternate freezing and thawing of winter if they are not protected with a mulch. About 2 to 4 inches of wheat straw makes a good mulch. Oat straw is not quite so good, since it mats together and may smother the plants. Pine needles make a fine strawberry mulch. Do not use mulching material with ripe seeds in it, for it may start a crop of weeds or grass among the plants. When spring growth begins rake most of the straw from above the plants into the spaces between rows, to hold soil moisture and to protect the berries from dirt.

Renewing old rows.—Spring-fruiting varieties planted one year produce their first crop the next year. In commercial practice these plants are usually plowed under soon after the crop is gathered, since the expense of cleaning up an old bed that has become weedy is too great. These fruiting rows can be renewed and cleaned up if they are plowed from one or both sides of the rows toward the centers and narrow strips left of the youngest plants recently grown for roots. Cut out old and surplus plants in the new rows, cultivate the plowed furrows to level the ground, and continue cultivating and fertilizing as though it were a new planting.

Before doing the plowing just mentioned above, it is well worth while to mow off the old strawberry leaves and when they are dry to burn them with a quick fire. A little straw scattered in thin places will help, and a breeze should be blowing so as to move the fire quickly across the patch and not to scorch the crowns of the plants. Diseases and insects on the plants will be destroyed by the fire.

Ever-bearing varieties.—The ever-bearing varieties are especially useful in the home garden, but are grown commercially in some sections. The following recommendations are given: Set the plants in early spring, give good care, and pick off the blossoms until July, then let the berries ripen for the fall crop. In the following spring let the spring crop mature and then plow under the plants. It is thus necessary to set new plants every spring. The old plants may be kept longer, but they usually do not give good results after this time.

Grapes

General.—The United States has three distinct viticultural regions. The Vinifera region, in which Vinifera or European varieties are almost exclusively grown, is located almost entirely west of the Rocky Mountains, in California, Arizona, and southern Oregon. The muscadine region of the South Atlantic and Gulf States includes the entire southeastern coastal plain extending from the Potomac River to Florida, reaching well up into the Blue Ridge Mountains, and along the Gulf coast to the Rio Grande, and spreading to the north along the Mississippi River in the great central plains to southeastern Missouri and the Tennessee River. The American native or bunch-grape region is the one in which improved varieties of the more northern native grape species and hybrids of them and the Vinifera species are grown.

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This region includes all that part of the United States which lies east of the Rocky Mountains. The industry is most extensive in the States west of the Hudson River and north of the Ohio River that border on the Great Lakes, and in the more centrally located States of the Mississippi Valley.

Soils.—Any good level or rolling, well-drained, loamy soil or rocky hillside will produce grapes. Rather coarse, sandy soil may be used, but it is not desirable, since it requires constant applications of manure and fertilizer.

Propagation.—The grape is usually propagated by cuttings of well-ripened new canes made in late fall, winter, or early spring. These cuttings should have three or four buds. Tie them in bundles and bury in moist sand or earth in a cool place. Store with bottom end up, and callus. Rooting at that end will take place more readily. Cuttings may be made in spring and planted at once, but they do not root quite so readily as when made earlier and allowed to callus. Plant the cuttings 4 inches apart in deep trenches, leaving only the top bud above the ground. Have the trenches 3 or 4 feet apart and cultivate well during the season. If the ground is dry the cuttings should be watered. After one or two years in the nursery row the plants may be set out in the vineyard.

Vinifera varieties for planting in phylloxera-infested soils should be bench worked on phylloxera-resistant roots or cuttings.

Heeling in vines.—Dig a trench and set the vines close together, then cover the roots with earth.

Planting.—Cut the roots back to 8 or 10 inches and the top to two buds. Dig a hole wide enough and deep enough to take in the root system, set the vine as deep as it was in the nursery, fill in the earth, and trample it down. Do the planting in the spring. Let two shoots grow and trail on the ground, or tie them to stakes.

Distances to plant.—Have the rows at least 8 feet apart; in some cases 10 feet is better, so as to have ample room for a spray rig. Set the plants 8 to 10 feet apart in the row.

Pruning.—There are two pruning systems, namely, renewal and spur. In renewal pruning a new cane or arm which grows one year is saved to bear fruit the next year. This fruiting cane or arm is cut off the next spring and a new one is saved to bear fruit that year. Thus a 1-year cane is always saved to bear fruit for one year and then discarded. Renewal means to renew or to save a new cane or arm for fruiting every year. This is the best system where trellises are used. In spur pruning the fruiting canes or arms are saved year after year, but all the shoots on them are pruned to spurs with two or three buds each. This system is used for arbors and sometimes for trellises.

Pruning the first year's growth.—If enough growth has been made to reach to the trellis wire, tie the shoot to the wire, for this will be the trunk of the plant. If the modified Munson system of training is used save one trunk. If the four-arm Kniffin system is used save either one or two trunks. If only a small growth has been made cut it off the next spring, leaving one spur of two buds, and consider the growth the second season to be the first year's growth as far as these directions are concerned.

Pruning the second year's growth.—In the modified Munson system save the best new arm or cane on each side at the top of the trunk and cut off all other growth. Save about eight buds on each arm and cut off the rest. Tie one arm in each direction on the center wire. In the four-arm Kniffin system save four good arms, two at

the upper wire and two at the lower, and cut off all the rest. These four arms may all be on one trunk or they may be two on each of two trunks. Tie one arm on each wire in each direction from the trunk.

Pruning the third and following years.—In the renewal save a good new arm near the trunk to take the place of each of the fruiting arms which are now cut off. Save about 10 buds on an arm and cut off the rest. Tie the arms to the wire. In the spur system save the two arms and cut last season's shoots back to spurs of two buds. Save the two arms for many years, and each spring cut the last year's shoots back to spurs of two buds. The pruning will be the same year after year for many years. If at any time it is desired to discard the old arms in the spur system, this can be done and new arms near the trunk can be saved.

Training.—There are many systems of training grapevines, but two of the best are the modified Munson and the four-arm Kniffin. (1) In the modified Munson system make a trellis by setting a row of posts 5 feet high and about 20 feet apart and nail a cross arm about 18 inches long to the top of each post. String two No. 12 or No. 14 wires on these cross arms, one wire near the ends on each side of the posts. Either bore holes through the posts 4½ feet above the ground and run another wire through these holes or staple the wire to the posts. Tie the arms of the vines to this wire, and as shoots grow they will droop over the two wires at the ends of the cross arms. No other tying is necessary. (2) In the four-arm Kniffin system make a trellis by setting a row of posts 20 feet apart and about 6 feet high. String two wires about 3 and 5 feet above the ground on these posts. In this system the vines may have one or two trunks. If there are two trunks, one reaches to the lower wire and supports two arms, one running in each direction and tied to the wire; the other trunk reaches to the top wire and likewise has two arms, one extending in each direction and tied to the wire. If there is only one trunk, it must support four arms, two on each wire, one running each direction from the trunk.

The spur, stool, globular, or goblet system is used in California for training the European varieties of grapes. A stake 3 or 3½ feet in length is set at each vine, and the first year's growth is tied to it and cut off from 18 to 24 inches from the ground the next spring. After the buds start growth the next year rub off all except two or three top ones. The next spring prune the shoots back to spurs having two buds each. Each spring following prune back to spurs of two buds and thin out all but half a dozen spurs. About the fifth year the trunk is strong enough to support itself and the stakes may be taken away.

Grafting Grapevines.—Dig away the earth from the vine to be grafted and cut it off at or below the ground level. Split the trunk and set in an ordinary cleft graft of the variety desired. Tie a string around the trunk to hold the cion in place. Mound up the earth to the top bud of the cion.

Cultivation.—Grapes need cultivation throughout the season. Use cover crops as in ordinary orchard practice. Plow the cover crop under early in the spring and clean cultivate until time to sow cover-crop seed again in July or August.

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Subtropical Fruits

Noncitrus—*Persimmon* (*Oriental*).—The Japanese persimmon is not hardy and is grown only in most of the Southern States and in parts of California. The fruits are much larger than those of the native species. The Japanese persimmons are budded or grafted on native seedlings. The blossoms are like those of the native species. One variety, Gailey, is a good pollen producer, and every tenth tree, at least with all varieties except Tanenashi, should be a Gailey. The Tanenashi variety produces fruit readily without outside pollen. Persimmons will grow on almost any kind of soil used for orchard purposes. The trees usually are planted 18 to 20 feet apart, and sometimes as much as 25 feet each way, and are given the same cultivation and fertilizing as ordinary fruit trees. Some good varieties are Okame, Hachiya, Hyakume, Yemon, Triumph, Yedoichi, Ormond, and Tamopan, a Chinese variety.

Miscellaneous Fruits

Persimmon (Native).—Native of North America south of Pennsylvania. The persimmon is similar to the peach and plum in its choice of soil and location, but it will grow well on almost any kind of soil, from rich bottom land to poor, thin soil on the hilltops. Like fruit and nut trees, it is propagated by budding and grafting or by root or stem cuttings.

If the top of a young tree is cut off suckers will shoot up from the roots. These may be dug, each with a portion of the root system, to make new plants. Root cuttings and stem cuttings 6 or 8 inches long are made during the winter. Dip the ends at once into hot beeswax or seal with grafting wax. Keep in moist sand in a cool place until callus and roots form. Plant in nursery rows 4 to 6 feet apart and 6 and 8 inches apart in the row. Graft or bud when large enough, which will be in about two years.

To grow seedlings stratify the seeds as soon as taken from the fruit, if possible, so that they do not dry out. If they become dry soak them in hot water two or three days before planting. Plant in fall or spring in rows half an inch deep in a well-prepared seed bed. Give good care and transplant after one year to nursery rows 4 feet apart and 6 inches apart in the rows. Graft or bud the seedlings when they are 2 years old. Dig the trees one year after grafting or budding for planting in the orchard or on the lawn.

In orchard form the trees are planted 20 or more feet apart each way. They suceed well if planted with small fruits, or may occupy the ground alone. Not much pruning is necessary. Cut out crowding limbs and head back any shoots which make the tree unshapely. Most persimmon trees produce either male or female blossoms, and some trees produce both kinds of blossoms. The fruits are small, none being larger than 1½ to 2 inches in diameter, and are globular, conical, or oblong in shape. Shoto, Early Bearing, Golden Gem, Daniel Boone, Hicks, Kansas, Early Golden, and Smeech, a seedling variety originating in Tennessee, are some of the varieties grown.

NUTS

General

Nut culture represents one of the newest lines of American orcharding. Because of the lack of fundamental knowledge regarding nut culture, with the possible exception of the almond, pecan, and Persian (English) walnut, the industry should be entered with greater precaution than is necessary with most fruits. On the Pacific coast, within areas of established adaptability, the growing of almonds and Persian walnuts is now sufficiently stabilized to enable planting to proceed with no more risk than is to be expected with the citrus or deciduous fruit industries. In parts of the South pecan growing is fast aproaching a similar condition of stability. But in much of the North, where although the planting of nut trees offers an inviting field to those who at a small cost would increase appreciably their income from the land, the time has not come yet when the planting of large orchards on otherwise profitable land can be regarded as an economically sound practice. In that section nut culture should for the present be limited to the use of rich spots not now in good use and to decorative and shade plantings, and to the top-working of inferior kinds with cions of varieties likely to bear more profitably. Nut growing should nowhere be entered upon with the idea that no serious pests, diseases, or other drawbacks are involved. Each species has its full quota of such troubles.

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Production and value of nut crops

[Bureau of Census, 1919]

State	Pecans		Almonds		Persian walnuts	
	Pounds	Value	Pounds	Value	Pounds	Value
Alabama	1, 179, 735	$353, 924	4, 113	$1, 033	25, 900	$6, 484
Arizona	1, 103	330	10, 335	2, 583	871	219
Arkansas	348, 382	87, 106	1, 706	427	14, 254	3, 566
California	14, 125	4, 241	15, 699, 748	3, 924, 940	59, 091, 390	17, 727, 417
Colorado					1, 152	289
Delaware	1, 777	889			9, 428	3, 771
District of Columbia					10	4
Florida	1, 025, 673	307, 705				
Georgia	2, 544, 377	890, 535			311	78
Idaho			1, 306	326	9, 038	2, 260
Illinois	182, 347	45, 592				
Indiana	18, 440	5, 532	2	1	251	63
Iowa	235	71				
Kansas	252, 802	75, 841			1, 201	302
Kentucky	50, 352	15, 110			2, 839	711
Louisiana	2, 242, 859	672, 862			19, 807	4, 957
Maryland	1, 502	444	66	17	4, 733	1, 187
Mississippi	1, 559, 245	389, 823			32, 932	8, 242
Missouri	555, 184	166, 561	307	77	905	227
Nebraska					2, 073	521
Nevada			2, 480	620	695	173

New Jersey	10	3			5,977	1,496
New Mexico	626	189	542	136	841	213
New York	191	57	360	91	10,788	2,699
North Carolina	145,753	43,736			25,576	6,396
Ohio	417	126			205	51
Oklahoma	4,296,642	859,331				
Oregon	352	106	29,945	7,489	461,845	115,467
Pennsylvania	111	34				
South Carolina	525,783	157,734				
Tennessee	70,594	17,654			1,365	344
Texas	16,755,421	3,686,191	41,073	10,274	7,049	1,768
Utah	583	175	48,653	12,165	12,138	3,036
Virginia	33,927	10,184				
Washington			12,335	3,085	96,843	24,217
Total	31,808,548	7,792,086	15,852,965	3,963,264	59,840,407	17,916,158

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Location.—Locating an orchard involves fewer difficulties for nuts than for fruits, particularly with reference to perishability of the product, as the product is better adapted to shipping and the importance of being near a market is, therefore, not so great. Within general limits of range one locality is about as good as another, provided soil and climate are right. The nut market is not active until about Thanksgiving, and this gives an opportunity for the grower to harvest and place the nuts of most species on the market in sufficient time, regardless of the distance of the orchard from the marketing point. Most American species of cultivated nuts are best adapted to moderate altitudes.

Site.—An orchard site for nuts requires a uniform, well-drained soil that is free from undue exposure. In the Pacific Northwest and in the almond districts farther south, good air drainage is necessary for a successful crop. Elsewhere it is not ordinarily regarded as being of special importance.

Almond

General.—The origin of the species was in the Mediterranean Basin, and the date of the first important cultivation in the United States has been since 1890. The almond succeeds only in regions that are practically frostless after blooming begins, or about February 1. Conditions thus favorable are found only in interior valleys, mainly in central California and in parts of Utah and Nevada. The maximum range of altitude is 2,000 to 3,000 feet above sea level.

Soil.—The almond does best under conditions of soil moisture approaching dryness, but it will not endure extreme dryness. Unfertile, poorly drained, arid, or excessively alkaline soils should be avoided.

Varieties.—There is great need for improvement of varieties by breeding, since none of the present kinds is wholly satisfactory from any point of view. However, of the leading kinds grown the three Hatch varieties, Nonpareil, I. X. L., and Ne Plus Ultra, are the most desirable. The Drake and the Peerless are extensively grown and are well known to the trade, but they are of low quality and bring low prices. The Texas, Stuart, and Acampo Texas are grown easily and are popular with the growers, yet they are of medium quality and also bring low prices. The Ballard, Batham, Eureka, Long I. X. L., and Smith all appear promising. The Jordan, Klondike, and Princess bring relatively high prices, but are too expensive to grow to be profitable.

Propagation.—Propagated by the T-bud method in the same manner as the peach, with which it is readily hybridized or intergrafted. It differs from the peach in being a larger grower and in requiring drier conditions of atmosphere and soil, greater freedom from late frosts, and in being generally less hardy. Hard-shell varieties, little superior to peach pits, are sometimes grown in the East, but have no commercial value. So far as known all varieties are self-sterile and must be interplanted to insure pollination. The stocks used are sweet and bitter almond, and peach.

Planting.—The minimum distance for setting out almond trees is 27 by 27 feet and the average 30 by 30 feet. The best size of tree for planting is 3 to 5 feet in height.

Cultivation.—Use the same methods as for fruit trees.

Production.—The age of the tree at first bearing is 3 to 5 years, and for commercial bearing from 5 to 10 years. The nuts ripen from August to October, and are the

first of the home-grown species in the market. The average yield is about 700 to 800 pounds per acre. The approximate range in price per pound of unshelled nuts is 15 to 30 cents.

Butternut

The origin of the species was in northeastern United States and in southeastern Canada. The butternut is not cultivated for commercial nut production. Its range includes the northern part of that of the black walnut, to Nova Scotia. It has long been planted about farm buildings in the Northern States, from New England south to Maryland and west to Nebraska. The range of altitude is from 100 to 1,000 feet above sea level, although the species is not uncommon at 2,000 feet. Requires moderate rather than extreme temperature, and grows in deep, fertile, moist, yet well-drained soils. Black-walnut stock is used for grafting purposes, and it is propagated the same as the pecan. Trees should be planted 40 feet apart in rows that are 40 feet apart. The present leading varieties are Aiken and Deming.

Chestnut

Several species are under cultivation. These are from different parts of the United States, China, Japan, and Europe. The date of the first cultivation in this country was about 1800. The range of cultivation is from the Eastern States below middle New England south through the Appalachian Range and west to Missouri and Iowa. Chestnut is also grown to some extent in the foothills of eastern California, western Oregon, and in Washington. It grows well from sea level to 1,500 feet, and requires less moisture and fertility than most species of nuts, but it does not readily graft upon stocks of other species than that of the cion. It is propagated the same as the pecan. The trees should be set 40 by 40 feet. The age of the tree at first bearing is from 3 to 5 years, and the age at full bearing is 5 to 8 years. The leading varieties are Champion, Paragon, Progress, Fuller, and Boone. The chestnut is of little commercial importance in any section of the country, partly because of its having been largely wiped out by blight over much of its native range and partly because it has not been established in other sections. Its future development appears most likely to take place in the Middle West and in the northern parts of the Pacific coast. Blight from Asia has almost put chestnut growing out of existence in this country. For the present there is little to encourage planting of either American or European varieties east of the Ohio River. Japanese chestnuts are more resistant, but usually are of poor flavor and ordinarily rendered palatable only by roasting or by cooking in some other manner.

Filbert (Hazelnut)

The origin of the species was in the Mediterranean Basin, and although it has been cultivated in this country during recent years only, it has long been known in the East. It is best adapted to the moderately cold and humid parts of the country, particularly to those parts that have maritime conditions of climate and moderate temperature. The present range of commercial planting is largely confined to the Willamette Valley in Oregon and adjacent territory in Washington. It requires fertile soil, not too dry or too moist. Much of the crop failure,

formerly attributed to lack of hardiness in the East, is now believed to have been due to the pollen factor, since the filbert is self-sterile. The principal method of propagation now in use is by some form of layerage, although experimentally it has been grafted, particularly on Asiatic tree hazels. The best size for planting is from 2 to 3 feet, and the planting distance 20 by 20 feet. The age of the trees at first bearing is 3 to 5 years, and for commercial bearing from 5 to 10 years. The leading varieties are Barcelona, Du Chilly, White Aveline, Italian, Imperial, Merville de Bollwyller, and Nottingham.

Hickory

The genus is native in the eastern part of the United States and was first cultivated in the late seventies. The native range extends from Massachusetts to Georgia and west to eastern Nebraska, but the best hickories are more fruitful from Iowa to Pennsylvania than elsewhere. Hickory requires a deep, fertile soil with considerable moisture. Pecans or some rapid-growing forms of hybrid hickories are used as stocks. Trees should be planted 50 by 50 feet. The species of hickory, other than pecan, best adapted to cultivation is the shagbark. There are a number of varieties which when top-grafted on trees of bearing age quickly begin to bear. The most promising are the Kirtland, Weiker, and Manahan. Hickory hybrids somewhat more precocious and therefore more promising for planting are the Fairbanks, Siers, Beaver, and Laney.

Pecan

General.—The pecan is an American species found only in certain parts of the United States and Mexico. It has a wide range, being grown in the lower third of the Cotton Belt. It has not indicated its adaptability to the Pacific Northwest, nor in the main to California. There are localities in Arizona, and perhaps New Mexico, where under irrigation it appears to be fairly well adapted to planting, but necessary precautions should be taken in starting the crop. The native range extends from southwestern Texas north and east through rich bottom lands to southeastern Iowa and southern Indiana. Present orchard success is confined to the southern parts of the Gulf States and the South Atlantic coast from Norfolk, Va., to middle Florida, the most active center of interest being in southwestern Georgia. Its respective varieties grow readily in a climate that is warm, or dry, or humid. The so-called eastern varieties are apparently limited to the 1,000-foot altitude, but the wild pecan and the western Texas varieties have a successful range in excess of 2,000 feet.

Soil.—A deep, fertile soil, sufficiently porous to admit of free root growth, well drained yet by no means dry, is considered the best adapted to pecan culture. Localities in which the water table is within reach of the taproot seem to be preferred by the pecan.

Varieties.—Varieties now considered best for planting in the East are the Stuart, Schley, Pabst, Success, Moneymaker, and Alley; for Florida the Moore, Curtis, Simmons, Success, and Bradley; for eastern Texas the Delmas, Schley, Stuart, and Success; for western Texas the Burkett, Sovereign, and Halbert; and for Arizona the Schley, Delmas, Alley, Success, Burkett, and Sovereign.

Propagation.—Propagated by budding or grafting. Use the annular budding method, or whip, cleft, and bark graft. Use pecan stocks. Hickory stocks are not desirable. Top-working can be successfully done on either

the pecan or the hickory, and one may be grafted onto the other.

Planting.—Plant trees 60 by 60 feet, using 3 to 6 foot stock.

Cultivation.—Use the same methods as for fruit trees.

Production.—The age of the trees at first bearing is 5 to 8 years, and for commercial bearing 10 to 14 years. The average yield of well-cared-for mature orchards is 200 to 350 pounds per acre. The approximate range in price per pound for wild pecans is 15 to 30 cents, and for cultivated nuts 30 to 80 cents.

Papershell Pecans.—The term "papershell," with reference to pecans, has been extended in its application until it is now practically without significance. Although originally applied to those types of pecans having such thin shells that they could be easily cracked when two nuts were crushed together in one hand, the term during recent years has been made to include all cultivated varieties, many of which have fully as hard shells as the average wild nuts. Properly speaking, the term "papershell" never referred to a particular variety. Its correct application has been only to varieties having very thin shells.

Walnut

Black Walnut.—Species originated in the eastern United States, and has been cultivated since about 1890, but most actively since 1915. The present range of cultivation of black walnut extends from lower New England to Michigan and Iowa and southward, though it is not well adapted to Gulf coast conditions. Does well in western Oregon and Washington. It is sometimes grown at an altitude of 5,000 feet above sea level, but for nut production it should not be planted above 1,000 feet. Requires considerable moisture in the soil, and thrives well under irrigation. It is propagated the same as the pecan. Black-walnut stocks are used. Trees should be set 60 by 60 feet apart. The age of the tree at first bearing is 3 to 6 years, and age at full bearing from 8 to 15 years. The leading varieties are Stabler, Thomas, Ohio, and Ten Eyck.

This species ranks second in potential value to the pecan among the native nut producers. Were it not for the shell thickness and the consequent difficulty in extracting the kernel it would doubtless be one of the leading nut species on the market, since the flavor and richness of the kernel are excellent. Varieties of superior cracking quality have been brought to light from among the seedling trees of the country. It is a most valuable dual-purpose tree, being a producer of highly palatable nuts as well as one of the most highly prized timber-producing trees.

Japanese Walnut.—Originated in Japan, and has been cultivated since the middle of the nineteenth century. It appears to have a range of adaptability much the same as that of the black walnut. It is a comparatively new introduction and is hardly known to the nut-consuming trade. The trees are small in size of growth as compared with the black walnut, earlier to come into bearing, as they often yield their first fruit at from 3 to 5 years, and are prolific and handsome. The nuts are smaller than those of the black walnut, lighter colored, and of very different form. The flavor of the kernel resembles closely that of the native butternut. Two recognized varieties, Faust and Lancaster, are available from the nurseries. Trees should be set out in the orchard at a distance of 40 feet apart each way.

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Persian (English) Walnut—*General.*—Species originated in southwestern Asia and has been under important cultivation in the United States since 1890. Is successful only in the far Western States, mainly in California, Oregon, and southwestern Washington. The principal center is around Los Angeles in southern California. Planting is constantly being increased in central California, northwestern Oregon, and contiguous territory north of Portland. Should be grown under 2,000 feet of altitude. The climatic requirements are moderate but uniform temperatures, considerable moisture, and freedom from radical drops in temperature.

Soil.—Requires a deep, rich, and fairly moist soil, thriving well under irrigation.

Varieties.—Varieties best for planting in southern California are the Placentia, Eureka, Ehrhardt, and Payne; for central California, the Eureka, Grove, Franquette, Payne, and Concord; and for Oregon, the Franquette, Mayette, and Meylan.

Propagation.—On the western coast it usually is grafted on the northern California black-walnut stock. Various hybrids are sometimes used as stocks, but they are too uncertain for general consideration. The whip-graft method is used in propagation on the western coast.

Planting.—The great bulk of plantings in California are of seedling trees, but recent plantings are almost wholly of standard varieties. The species is more or less self-sterile, and varieties should be interplanted. So far as known insects do not assist in pollen distribution. The best size of tree for planting is 6 to 8 feet in height, and the proper planting distance is 60 feet each way. If planted far enough apart and trained properly, the trees require little pruning.

Cultivation.—Use the same methods as for fruit trees.

Production.—The age of tree at first bearing is 4 to 6 years and for commercial bearing 8 to 10 years. The ripening season in southern California is from September to early November. The average yield is about 800 to 900 pounds per acre. The approximate range in price per pound is 16 to 32 cents.

Miscellaneous Nuts

Several species of edible nut-producing trees from near the Tropics have been introduced and now are being grown experimentally in the warmer parts of Florida and California. These are yet entirely without commercial status. They include the pistache, the coconut, the cashew, and the Queensland nut. The Brazil nut, more commonly called "niggertoe," has thus far failed entirely to be hardy in any part of Florida. So far as known the pili nut of the Asiatic Tropics has not been found hardy in any portion of this country. The lychee succeeds well in Honolulu, but there are no important plantings in the United States.

VEGETABLES

General

Truck crops, commercial crop: Acreage and production, United States, 1921–1924

ACREAGE

Crop	Number of States producing	1921	1922	1923	1924
		Acres	*Acres*	*Acres*	*Acres*
Asparagus	12	32, 140	32, 860	42, 050	49, 420
Bean, snap	30	34, 830	49, 550	61, 280	75, 390
Cabbage	28	104, 580	133, 830	104, 880	109, 960
Cantaloupe	23	77, 450	103, 300	84, 160	89, 700
Carrot	8	----------	----------	9, 770	10, 720
Cauliflower	5	8, 510	9, 250	11, 580	13, 190
Celery	10	16, 250	17, 230	19, 760	21, 380
Corn, sweet	20	136, 280	197, 600	250, 850	299, 410
Cucumber	29	80, 610	82, 200	91, 960	129, 580
Eggplant	3	2, 420	2, 210	2, 470	2, 390
Lettuce	14	31, 240	44, 900	57, 990	63, 060
Onion	22	57, 070	63, 290	61, 940	59, 900
Pea, green	23	133, 850	171, 800	206, 690	241, 620
Peppers	4	7, 530	7, 860	8, 030	10, 320
Potato (early)	19	265, 920	311, 930	281, 740	307, 540
Spinach	9	22, 810	23, 760	30, 550	33, 600
Strawberry	27	109, 590	132, 800	148, 360	146, 750
Tomato	33	160, 010	345, 420	409, 890	469, 860
Watermelon	22	155, 660	211, 060	157, 350	168, 230

PRODUCTION

Crop	1921	1922	1923	1924
Asparagus.....crates	3, 287, 000	4, 041, 000	5, 854, 000	6, 761, 000
Bean, snap.....tons	66, 800	79, 600	100, 300	104, 500
Cabbage.....do	687, 000	1, 089, 000	805, 700	973, 000
Cantaloupe.....crates	11, 549, 000	12, 805, 000	11, 745, 000	13, 789, 000
Carrot.....bushels	----------	----------	3, 184, 000	3, 804, 000
Cauliflower.....crates	2, 293, 000	2, 589, 000	3, 322, 000	3, 514, 000
Celery.....do	4, 401, 000	4, 601, 000	5, 333, 000	6, 114, 000
Corn, sweet.....tons	360, 600	474, 700	590, 600	500, 500
Cucumber.....bushels	8, 267, 000	8, 867, 000	7, 671, 000	8, 058, 000
Eggplant.....do	882, 000	856, 000	850, 000	640, 000
Lettuce.....crates	8, 931, 000	10, 829, 000	14, 118, 000	13, 653, 000
Onion.....bushels	14, 165, 000	18, 763, 000	17, 306, 000	17, 627, 000
Pea, green.....tons	125, 800	181, 700	180, 100	259, 200
Peppers.....bushels	2, 874, 000	2, 654, 000	2, 953, 000	3, 500, 000
Potato (early).....do	30, 193, 000	36, 198, 000	26, 245, 000	41, 178, 000
Spinach.....tons	61, 700	67, 900	95, 800	105, 400
Strawberry.....quarts	189, 670, 000	260, 403, 000	256, 409, 000	266, 951, 000
Tomato.....tons	724, 200	1, 658, 000	1, 723, 200	1, 718, 900
Watermelon.....number	61, 774, 000	71, 128, 000	42, 734, 000	49, 765, 000

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Production and value of leading truck crops, 1924

Product	Acreage	Yield per acre	Production	Price per unit	Total value
Asparagus:					
Table	26, 280	103 crates	2,719,000 crates	$3. 82	$10, 373, 000
Canning	23, 140	2.1 tons	48,500 tons	99. 15	4, 809, 000
Beans, snap:					
Table	55, 350	99 hampers	5,480,000 hampers	1. 68	9, 231, 000
Canning	20, 040	1.9 tons	38,700 tons	68. 55	1, 653, 000
Beans, dry	1, 376, 000	9.7 bushels	13,327,000 bushels	3. 71	49, 494, 000
Cabbage	109, 960	8.8 tons	973,000 tons	16. 14	15, 705, 000
Carrot	10, 720	355 bushels	3,804,000 bushels	10. 95	3, 603, 000
Cauliflower	13, 190	266 crates	3,514,000 crates	1. 45	5, 103, 000
Celery	21, 380	283 crates	6,114,000 crates	2. 54	16, 034, 000
Corn, sweet, for canning	299, 410	1.7 tons	500,500 tons	14. 19	7, 100, 000
Cucumber:					
Table	36, 680	144 hampers	5,272,000 hampers	1. 76	9, 304, 000
Manufacturing	92, 900	30 bushels	2,786,000 bushels	1. 00	2, 964. 000
Eggplant	2, 390	268 bushels	640,000 bushels	1. 61	1, 030, 000
Lettuce	63, 060	217 crates	13,653,000 crates	1. 21	16, 553, 000
Muskmelon	89, 700	154 crates	13,789,000 crates	1. 47	20, 730, 000
Onion	59, 900	294 bushels	17,627,000 bushels	. 95	16, 751, 000
Pea, green:					
Table	21, 460	75 hampers	1,608,000 hampers	1. 80	2, 890, 000
Canning	220, 160	1.1 tons	233,500 tons	59. 45	13, 881, 000
Pepper	10, 320	339 hampers	3,500,000 hampers	1. 85	6, 477, 000

Potato:					
Early	307, 540	134 bushels	41,178,000 bushels	1. 07	44, 182, 000
Late	3, 662, 000	124.2 bushels	454,784,000 bushels	. 64	292, 481, 000
Sweet	938, 000	76.6 bushels	71,861,000 bushels	1. 29	92, 290, 000
Spinach:					
Table	23, 850	414 bushels	9,883,000 bushels	. 61	6, 022, 000
Canning	9, 750	4.7 tons	46,100 tons	20. 72	955, 000
Tomato:					
Table	156, 780	120 bushels	18,740,000 bushels	1. 95	36, 571, 000
Manufacturing	313, 080	3.8 tons	1,194,200 tons	15. 19	18, 070, 000
Watermelon	168, 230	296 melons	49,765 cars	171. 00	8, 503, 000

U. S. D. A.—10-1-26

Canned vegetables: Production and value, 1914, 1919, 1921, 1923

[Bureau of the Census]

Kind	1914	1919	1921	1923
Asparagus:				
Cases	637, 601	1, 006, 604	739, 853	1, 461, 808
Value.....dolls..	2, 790, 817	6, 571, 629	5, 137, 372	10, 955, 246
Beans:				
Cases	8, 994, 302	14, 824, 232	11, 315, 822	20, 468, 094
Value.....dolls..	16, 565, 021	39, 408, 603	30, 711, 958	39, 638, 058
Beets:				
Cases	251, 632	584, 309	390, 720	544, 641
Value.....dolls..	511, 900	1, 951, 344	1, 203, 464	1, 763, 054
Corn:				
Cases	9, 919, 950	14, 402, 725	9, 010, 660	14, 703, 519
Value.....dolls..	13, 923, 057	35, 532, 007	19, 549, 766	30, 832, 664
Peas:				
Cases	8, 826, 284	9, 325, 727	8, 222, 181	14, 434, 273
Value.....dolls..	15, 089, 047	25, 073, 220	22, 953, 181	39, 767, 830
Spinach:				
Cases	391, 790	676, 388	581, 030	1, 875, 397
Value.....dolls..	736, 686	2, 338, 497	2, 086, 839	4, 978, 423
Sweet potatoes:				
Cases	454, 415	745, 861	622, 827	[1]
Value.....dolls..	736, 759	2, 477, 719	41, 807, 735	[1]
Tomatoes:				
Cases	16, 200, 302	11, 836, 476	4, 133, 654	14, 781, 034
Value.....dolls..	25, 532, 217	38, 067, 999	12, 508, 654	39, 677, 383

[1] Not reported separately.

Standard case contains 24 cans.

Yield and maturity table of vegetables

Product	Days from seed	Yield per acre	Price per unit
Asparagus:			
Table	[1] 3 to 4	100 to 140 crates	\$3. 00 to \$5. 00
Canning	[1] 3 to 4	2 to 3 tons	85. 00 to 100. 00
Beans:			
Green or snap	45 to 65	75 to 120 bushels	1. 50 to 3. 00
Dry, shelled	65 to 85	11 to 20 bushels	3. 00 to 4. 00
Lima, fresh in pod	90 to 110	75 to 120 bushels	1. 50 to 2. 00
Dry, shelled	110 to 130	18 to 24 bushels	3. 50 to 6. 00
Beets:			
Bunching	45 to 65	1,200 dozen bunches	. 40 to 1. 20
Mature for storage	60 to 90	400 to 600 bushels	. 30 to 1. 00
Cabbage:			
Early	70 to 100	80 to 130 crates	1. 25 to 4. 00
Late	120 to 150	7 to 12 tons	6. 00 to 40. 00

[1] Years.

Yield and maturity table of vegetables—Continued

Product	Days from seed	Yield per acre	Price per unit
Carrots:			
Bunching	45 to 65	1,600 dozen bunches	$0.30 to $1.00
Late, storage	120 to 150	400 to 700 bushels	.30 to 1.00
Cauliflower	110 to 130	250 to 300 crates	1.50 to 4.00
Corn, sweet:			
For market	65 to 85	400 to 600 dozen	.20 to .60
For cannery	70 to 90	2.5 to 4 tons	10.00 to 15.00
Cucumbers:			
Table	55 to 65	150 to 200 hampers	1.00 to 3.00
Pickle	50 to 70	30 to 50 bushels	.90 to 1.20
Eggplant	130 to 160	300 to 400 bushels	1.50 to 3.00
Horse-radish	[2] 6 to 7	3 to 5 tons	50.00 to 85.00
Lettuce	70 to 90	200 to 400 crates	1.00 to 2.50
Muskmelon	90 to 110	120 to 180 crates	1.50 to 2.50
Onion:			
From sets	80 to 100	200 to 400 bushels	.85 to 1.40
From seed	90 to 120	200 to 600 bushels	.85 to 1.40
Pepper, sweet	120 to 150	300 to 400 hampers	1.50 to 3.00
Parsnip	120 to 150	400 to 700 bushels	.40 to .85
Pea:			
Green, in pod	70 to 80	70 to 120 hampers	1.80 to 2.50
Canning	70 to 80	1 ton	55.00 to 65.00
Potato:			
Early	90 to 130	100 to 350 bushels	.80 to 2.00
Late	110 to 130	100 to 400 bushels	.40 to 1.60
Sweet	130 to 160	100 to 300 bushels	.40 to 2.50
Spinach:			
Table	50 to 70	300 to 600 bushels	.60 to 1.20
Canning	60 to 70	4 to 6 tons	20.00 to 25.00
Squash:			
Summer	60 to 70	80 to 120 bushels	.40 to 1.50
Winter	120 to 130	3 to 6 tons	20.00 to 45.00
Tomato:			
Early table	140 to 160	130 to 180 bushels	1.50 to 4.00
Canning	120 to 150	Average 4 tons	12.00 to 18.00
Turnip	60 to 80	400 to 1,000 bushels	.30 to 1.00
Watermelon	120 to 140	250 to 350 melons	.10 to .50

[2] Months.

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Commercial vegetable planting table

Kind	Distance between rows	Distance between plants or hills	Depth to plant	Quantity of seed or number of plants per acre
Asparagus	5 to 7 ft	18 to 30 ins	5 to 7 ins	4 to 6 ozs. seed, 4,300 to 5,800 pl'ts.
Beans:				
Snap and dry	28 to 36 ins	4 to 6 ins	1½ to 2 ins	½ to 1¼ bus
Bush Lima	32 to 38 ins	5 to 7 ins	1½ to 2 ins	1 to 1¼ bus.
Pole Lima	4 to 5 ft	2½ to 3 ft	1½ to 2 ins	¾ to 1 bus.
Cabbage:				
Early	28 to 36 ins	10 to 13 ins	½ to 1 in	6 to 8 ozs., 12,000 to 17,000 pl'ts.
Late	34 to 42 ins	15 to 20 ins	½ to 1 in	6 to 8 ozs., 10,000 to 12,000 pl'ts
Beet	15 to 24 ins	3 to 5 ins	1 to 1¼ ins	4 to 8 lbs.
Carrot	12 to 30 ins	3 to 4 ins	½ to 1 in	4 to 6 lbs.
Cauliflower	35 to 40 ins	18 to 24 ins	½ to 1 in	3 to 4 ozs., 8,000 to 10,000 pl'ts.
Celery	28 to 48 ins	4 to 6 ins	¼ in. seed bed	2 to 4 ozs., 22,000 to 52,000 pl'ts.
Corn, sweet	3 to 4 ft	15 to 18 ins	1½ to 2 ins	8 to 12 lbs.
Cucumber	7 to 10 ft	6 to 8 ft	1 to 1½ ins	1 to 2 lbs.
Eggplant	3 to 4 ft	2 to 3 ft	½ in. seed bed	8 to 10 ozs., 3,500 to 7,200 pl'ts.
Lettuce	15 to 18 ins	8 to 10 ins	½ in	4 to 8 ozs. for transplanting, 1 lb. seeded in place.
Onions	12 to 18 ins	3 to 4 ins	¾ to 1 in	4 to 6 lbs.
Pea:				
In row	28 to 36 ins	1 to 2 ins	1 to 3 ins	2½ to 3 bus.
Broadcast			2 to 3 ins	4 to 5 bus.
Pepper	30 to 36 ins	18 to 30 ins	½ in. seed bed	4 to 6 ozs., 8,500 to 11,000 pl'ts.
Potato	32 to 42 ins	12 to 18 ins	3 to 5 ins	8 to 15 bus.
Sweet potato	28 to 42 ins	10 to 18 ins	3 to 5 ins	6 to 7 bus., 8,000 to 10,000 pl'ts.
Spinach	7 to 10 ins	1 to 2 ins	¾ to 1 in	8 to 12 lbs. in rows, 18 to 20 lbs. broadcast
Tomato	3 to 5 ft	3 to 4 ft	¾ in. seed bed	2 to 4 ozs., 3,600 to 4,800 pl'ts.
Tomato, staked	3 to 5 ft	18 to 24 ft	¾ in. seed bed	4 to 6 ozs., 8,000 to 10,000 pl'ts.
Watermelon	8 to 12 ft	8 to 10 ft	1 to 1½ ins	1 to 2 lbs., 7 seeds to hill.

Home gardeners' planting table: Quantity of seeds and number of plants required for 100 feet of row, depths of planting, and distances apart for rows and plants

Kind of vegetable	Required for 100 feet of row		Depth for planting seed	Distances apart		
				Rows		Plants in the row
	Seed	Plants		Horse cultivation	Hand cultivation	
			Inches	*Feet*		
Asparagus	¼ oz	60 to 80	1 to 1½	4 to 6	2½ ft	15 to 18 ins.
Bean:						
Bush	1 pt		1½ to 2	2½ to 3	2 ft	3 to 4 ins.
Bush Lima	½ pt		1½ to 2	3	2½ ft	6 to 10 ins.
Pole Lima	½ pt		1½ to 2	4	4 ft	3 to 4 ft.
Beet	2 ozs		1 to 1½	2 to 2½	15 to 18 ins	4 to 5 ins.
Cabbage	¼ oz	65 to 90	½	2½ to 3	2 to 2½ ft	14 to 18 ins.
Carrot	1 oz		½	2 to 2½	15 to 18 ins	3 to 4 ins.
Cauliflower	⅛ oz	60 to 75	½	2½ to 3	2 to 2½ ft	15 to 18 ins.
Celery	⅛ oz	200 to 250	⅛	3 to 4	18 to 24 ins	4 to 6 ins.
Collard	¼ oz	65 to 100	½	2 to 2½	18 to 24 ins	12 to 18 ins.
Corn, sweet	¼ pt		2	3 to 3½	3 to 3½ ft	10 to 12 ins.
Cucumber	¼ oz		1 to 1½	4 to 5	4 to 5 ft	15 ins.
Eggplant	¼ oz	50 to 70	½	3	2 to 2½ ft	18 to 24 ins
Kale	½ oz		½	2½ to 3	18 to 24 ins	8 to 10 ins.
Lettuce	½ oz	125 to 200	½	2 to 2½	15 to 18 ins	6 to 10 ins.

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Home gardeners' planting table: Quantity of seeds and number of plants required for 100 feet of row, depths of planting, and distances apart for rows and plants—Continued

Kind of vegetable	Required for 100 feet of row		Depth for planting seed	Distances apart		
				Rows		
	Seed	Plants		Horse cultivation	Hand cultivation	Plants in the row
			Inches	*Feet*		
Melon:						
Muskmelon	¼ oz		1 to 1½	5 to 6	5 to 6 ft	Drills, 24 ins. Hills, 5 ft.
Watermelon	¼ oz		1 to 2	8 to 10	8 to 10 ft	Drills, 2 to 3 ft. Hills, 8 ft.
Okra	1 oz		1 to 2	4	3 ft	2 ft
Onion:						
Seed	1 oz		½ to 1	2	15 ins	3 to 4 ins.
Sets	1 qt		1 to 2	2	15 ins	3 to 4 ins.
Parsley	¼ oz		⅛	2	15 ins	3 to 4 ins.
Parsnip	½ oz		½ to 1	2 to 2½	15 to 18 ins	3 to 4 ins.
Pea	1 to 2 pts		2 to 3	3 to 4	2½ to 3 ft	1 in.
Potato:						
White	5 to 6 lbs.		4	2½ to 3	2½ to 3½ ft	12 to 18 ins.
Sweet	3 lbs	75 (slips)	2 to 3	3 to 4	3 to 4 ft	14 to 18 ins.
Radish	1 oz		½ to 1	2	12 to 15 ins	1 in.
Salsify	½ oz		½ to 1	2	15 to 18 ins	1 in.

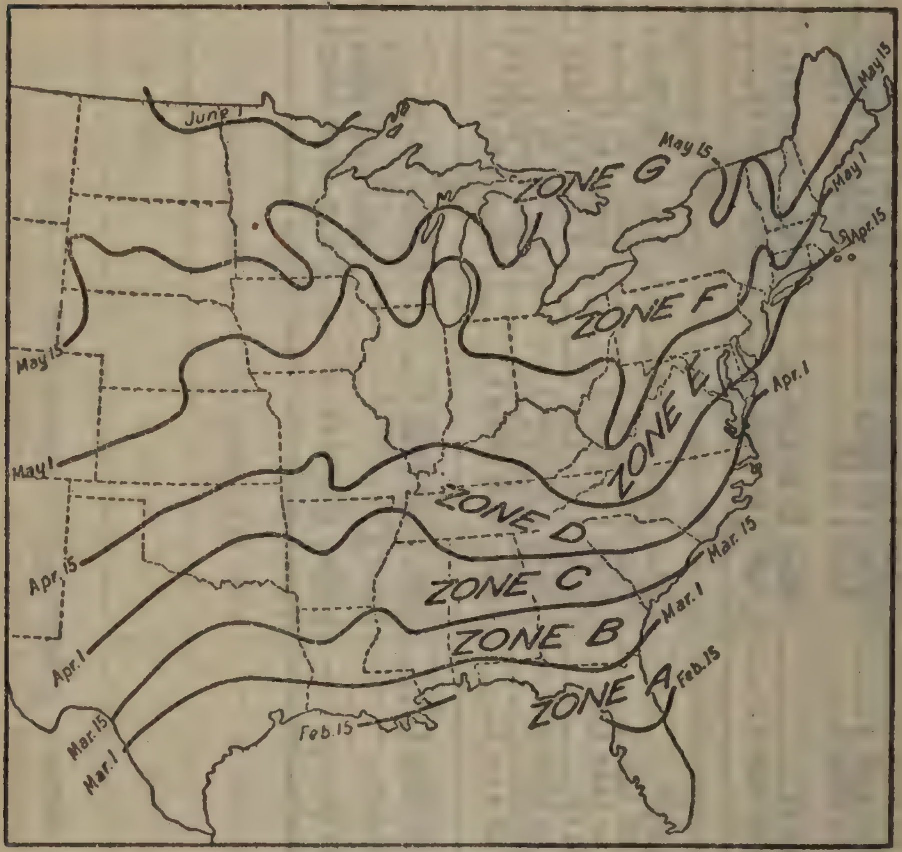
Spinach	1 oz		½ to 1	2	15 to 18 ins	1 to 2 ins.
Squash:						
Bush	¼ oz		1 to 2	3 to 4	3 to 4 ft	Drills, 15 to 18 ins. Hills, 4 ft.
Vine	¼ oz		1 to 2	7 to 10	7 to 10 ft	Drills, 2 to 3 ft. Hills, 8 ft.
Tomato	⅛ oz	35 to 50	½	3 to 4	2 to 3 ft	2 to 3 ft.
Turnip	½ oz		¼ to ½	2	15 to 18 ins	2 to 3 ins

Time of planting vegetable seeds: Earliest safe dates for planting vegetable seeds in the open in the zones of the eastern United States illustrated on map

Crop	Zone D	Zone E	Zone F	Zone G
Asparagus	Mar. 15 to Apr. 15	Apr. 15 to May 1	May 1 to 15	May 1 to June 1.
Artichoke:				
Globe	Apr. 15 to May 15	May 1 to 30	Not grown	Not grown.
Jerusalem	Mar. 15 to Apr. 1	Apr. 1 to 15	do	Do.
Bean:				
Snap	Apr. 1 to May 1	May 1 to 15	May 15 to June 1	May 15 to June 15.
Lima	May 1 to 15	May 15 to June 1	May 15 to June 15	
Beet	Mar. 15 to Apr. 15	Apr. 15 to May 1	May 1 to 15	Do.
Brussels sprouts	do	do	do	Do.
Broccoli	do	do	do	Do.
Cabbage	Mar. 1 to 15	Mar. 15 to Apr. 15	Apr. 15 to May 1	May 1 to May 15.
Carrot	Mar. 15 to Apr. 15	Apr. 15 to May 1	May 1 to 15	May 1 to June 1.
Cauliflower	do	do	do	Do.
Celery	do	do	do	Do.
Chard	do	do	do	Do.
Collard	Mar. 1 to 15	Mar. 15 to Apr. 15		
Corn, sweet	Apr. 1 to May 1	Apr. 15 to May 15	May 1 to June 1	May 15 to June 15.
Cucumber	Apr. 15 to May 1	May 1 to June 1	May 15 to June 15	June 1 to 15.
Eggplant	do	do	do	Season too short.
Garlic	Mar. 1 to 15	Mar. 15 to Apr. 15	Apr. 15 to May 1	May 1 to 15.
Kale	do	do	do	Do.
Kohl-rabi	Mar. 15 to Apr. 1	Apr. 1 to May 1	May 1 to 15	May 15 to June 1.
Lettuce:				
Head	Mar. 15 to Apr. 15	do	do	Do.
Leaf	Mar. 1 to 15	Mar. 15 to Apr. 15	Apr. 15 to May 1	May 1 to 15.

Melons	Apr. 15 to May 1	May 1 to June 1	June 1 to 15	
Mustard	Mar. 15 to Apr. 1	Apr. 1 to May 1	May 1 to 15	May 15 to June 1.
Okra, or gumbo	Apr. 15 to May 1	May 1 to 15	May 15 to June 1	June 1 to 15.
Onion:				
Sets	Mar. 1 to 15	Mar. 15 to Apr. 15	Apr. 15 to May 1	May 1 to 15.
Seeds	Mar. 15 to Apr. 1	Apr. 1 to May 1	May 1 to 15	May 15 to June 1.
Parsley	do	do	do	Do.
Parsnip	do	do	do	Do.
Pea:				
Smooth	Mar. 1 to 15	Mar. 15 to Apr. 15	Apr. 15 to May 1	May 1 to June 1.
Wrinkled	Mar. 15 to Apr. 1	Apr. 1 to May 1	May 1 to 15	May 15 to June 1.
Pepper	Apr. 15 to May 1	May 1 to June 1	June 1 to 15	
Potato	May 1 to 15	Mar. 15 to Apr. 15	Apr. 15 to May 1	May 1 to June 1.
Pumpkin	Apr. 15 to May 1	May 1 to June 1	June 1 to 15	
Radish	Mar. 1 to 15	Mar. 15 to Apr. 15	Apr. 15 to May 1	May 1 to 15.
Rhubarb	Mar. 15 to Apr. 15	Apr. 15 to May 1	May 1 to 15	May 15 to June 1.
Salsify	do	do	do	Do
Spinach	do	do	do	Do.
Squash	Apr. 15 to May 1	May 1 to June 1	June 1 to 15	
Sweet potato	do	do	do	
Tomato	do	do	May 15 to June 15	June 1 to 15.
Turnip	Mar. 1 to 15	Mar. 15 to Apr. 15	Apr. 15 to May 1	May 1 to 15.

In parts of zone D cabbage, turnip, spinach, and kale will withstand the winter and may be planted in the fall. With protective covering these same crops may be carried through the winter in portions of zone E. Several of the crops listed can not be grown in portions of zones F and G, as the season is either too short or the average temperature too low for successful development of the crops, this being particularly true of eggplant, sweet potatoes, sweet corn, and melons. Beets, early cabbage plants, cauliflower, kale, onion sets, smooth peas, potatoes, and radishes may be planted two weeks before the average date of the last killing frost. Carrot, lettuce, onion seed, wrinkled pea, spinach, and sweet corn may be planted about the date of the last killing frost.



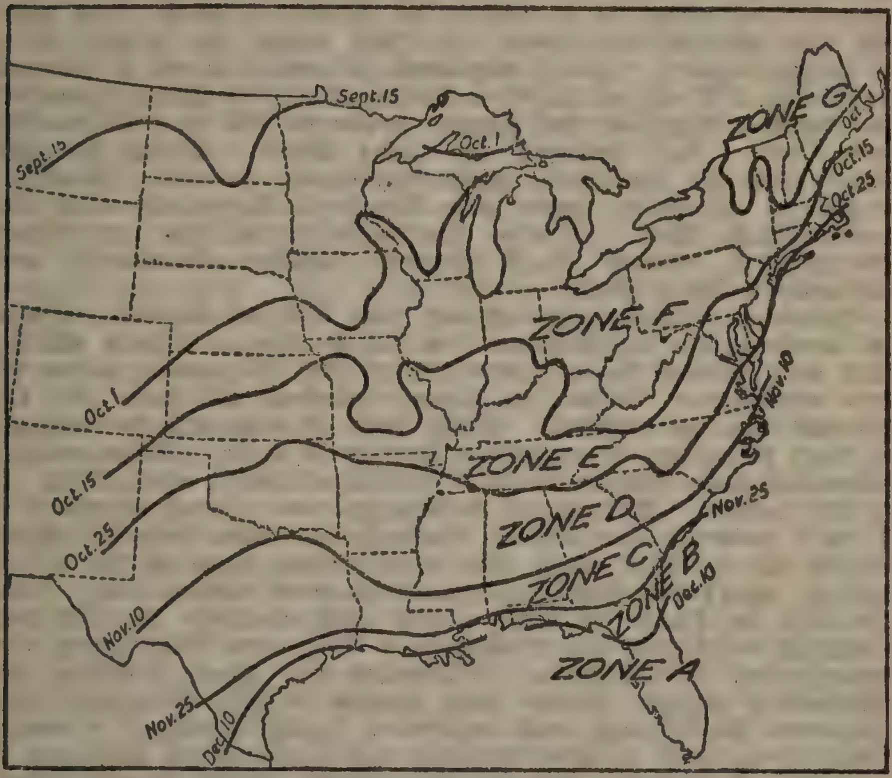
Zone map of the eastern United States, based on the average dates of the last killing frost in spring

Bean, salsify, and tomato plants may be planted two weeks after the last killing frost, but the heat-loving plants, such as peppers, eggplant, Lima beans, and squash should not be planted in the open until the ground has warmed, which will be about four weeks after the last killing frost.

Location.—Success of any vegetable-growing enterprise depends upon the location of the grower in respect to markets and transportation facilities. Production on a carload basis should not be undertaken in a section where the enterprise is new and untried. If the crop can be grown in a given location, try it on a small scale at first; then, when its production has proved successful, organize the growers of the community so as to produce the commodity on a shipping basis. Such crops as muskmelons, lettuce, and celery are shipped successfully across the continent because of the fact that both the

production and marketing of these crops have been placed upon an organized basis.

Site.—Local conditions, such as soil area, drainage, protection from frost, adaptability of crop to local farm conditions, and problems that affect the local production of the commodity, should be considered in the selection of a site. Certain vegetable crops are adapted to growing on low ground, where late spring and early fall frosts may occur. On the other hand, many of the more tender crops must be planted on land that is free from late spring and early fall frosts, and require good soil drainage and conditions that promote rapid



Zone map of the eastern United States, based on the average dates of the first killing frost in the fall

growth. The selection of the site, like that of location, may easily determine the success or failure of any vegetable-growing enterprise.

Root and Tuber Crops

General.—This group includes the most important of our food vegetables. Root and tuber crops for the most part are adapted to intensive cultivation and yield a large food value on a limited area. The soil should be well drained, but naturally retentive of moisture, and drought resistant. These crops do best on rich, sandy loams having a clay subsoil, on the light clay loams, and on river-bottom or alluvial soils. Certain of the root crops give good results when grown on the muck or peat soils, especially those soils that are underlain by marl and are alkaline in nature. Rotted manure should be applied in advance of planting and thoroughly mixed with the soil. Commercial fertilizers varying in composition, according to the crop to be grown, are used

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in rates varying from 600 to 2,000 pounds to the acre. The mixture most commonly used for growing carrots, beets, parsnips, and salsify contains about 5 per cent of nitrogen, 8 per cent of phosphoric acid, and 5 or 6 per cent of potash. For potatoes and sweet potatoes the nitrogen content is frequently cut down to 3 per cent and the potash increased to 7 or 8 per cent. Thorough soil preparation and intermixing of the fertilizer or manure with the soil is important in the production of root crops.

Beet.—To produce an early crop grow in hotbeds and coldframes, or plant in open ground as soon as the soil can be worked. Can be planted as soon as danger of frost is passed. Sow the seeds in drills 14 to 18 inches apart, covering to a depth of about 1 inch. As soon as the plants are well up thin them to stand 3 or 4 inches apart. Seed required is about 4 to 6 pounds per acre. Yield of garden beets is 1,200 dozen bunches per acre. Yield of full-grown beets is 250 to 600 bushels per acre. Not injured by light frost. Store in outdoor pits or in cool, well-ventilated cellars. Leading varieties of table beets are Crosby's Egyptian and Detroit Dark Red. Those for stock feeding are Klein Wanzleben, Giant Half Sugar, Golden Tankard, and Mammoth Long Red.

Carrot.—Grown throughout the United States. Plant in hotbeds or coldframes for early crop. Plant during fall and winter in extreme South for shipment to northern markets. Plant in home garden as soon as the ground can be worked. Fifty feet of row will be enough of first planting to supply a family of four. Make second planting four weeks later. Width of rows should be 12 to 30 inches. Thin to 2 inches in row. Seed required is 4 to 6 pounds per acre. Carrots are also grown extensively as a field crop, the rows being spaced 18 to 30 inches apart for horse or small tractor cultivation. Seed planted in June or early July will mature in October. Leading varieties are Chantenay, Danvers Half-Long, Oxheart, and Hutchinson. Varieties for stock feeding are Improved Short White and Large White Belgian, also Danvers Half-Long and Improved Long Orange. Carrots yield from 250 to 600 bushels per acre when allowed to mature, and need not be dug until after heavy frost. Store in pits or in cool, well-ventilated cellars.

Parsnip.—Plant and cultivate the same as carrots, except that rows should not be less than 24 inches apart for hand cultivation and 30 to 36 inches for horse culture. Thin to 3 or 4 inches in the row. Plant during the latter part of April or during May in the North, and give a full season's growth. The parsnip requires a rich soil and frequent cultivation. Dig and store in pits or leave where grown until wanted for use. Not injured by freezing if not disturbed. Hollow Crown is the leading variety.

Potato—*General.*—Native of South America, and was introduced into the United States by way of Europe during the early colonial days. The potato is now the most important vegetable grown for the market, and its production is roughly divided into the early potato industry of the South and the late potato of the North.

Early varieties.—The leading varieties of early potatoes are Irish Cobbler, Bliss Triumph (or Red Triumph), Early Ohio, and Spaulding Rose. Irish Cobbler is rapidly replacing all other varieties as an early potato in most sections.

Late varieties.—The list of late varieties includes Green Mountain, Rural New Yorker, Russet Rural, Peerless (Pearl of Colorado), Russet Burbank (Idaho),

Charles Downing (Idaho Rural), Prolific (Brown Beauty of San Louis Valley), White Skin Burbank (Pacific coast and Colorado), and Up-to-Date (British Queen). Irish Cobbler is grown as a late crop in the northern sections for seed stock with which to plant the early crop in the South.

Seed certification.—Regulations governing the inspection and certification of seed potatoes vary, but most States require three field inspections and one tuber or bin inspection. In some States a shipping inspection is required. For the percentages of tolerance for various diseases see the inspection rules of each State. The diseases ordinarily covered are mosaic, curly dwarf, leaf-roll, spindling tuber, black-leg, wilt, rhizoctonia, and others. The highest tolerance for the first field inspection in any State is 11 per cent for all diseases (New York). The lowest tolerance for all diseases is 5 per cent (Michigan, Nebraska, North Dakota, and Wyoming). In Michigan the tolerance is reduced to 2 per cent for the second and third field inspections.

Fertilizers.—Growers of early potatoes along the Atlantic seaboard and Gulf coast regions apply 1 ton of fertilizer having an analysis of 4 per cent nitrogen, 8 to 10 per cent phosphoric acid, and 4 to 6 per cent potash per acre. The fertilizer is applied under the row and mixed with the soil before planting. Applications in the northern or late-potato sections vary with locality; in some places no fertilizer is used, but in others as high as 800 to 1,000 pounds are applied to an acre containing 3 to 4 per cent nitrogen, 8 to 10 per cent phosphoric acid, and 3 to 8 per cent of potash.

Rotation.—A four or five year rotation is recommended. A four-year rotation suggested for the northern districts includes corn one year, oats followed by wheat in the fall, clover sown on the wheat during the winter and the land allowed to remain in clover for one or two years, and then potatoes. A five-year rotation for the northern territory would consist of corn the first year, oats followed by wheat one year, clover two years, and potatoes. In the southern district a rotation including corn with cowpeas or velvet beans planted between the rows, followed by fall or winter oats, these to be followed by cowpeas during the second season of the rotation, and potatoes the third season. This would make a three-year rotation, having corn, oats, and potatoes as the main crops, and cowpeas or velvet beans as the soil-building crops. In the West potatoes frequently are planted on land that has been in alfalfa four or five years, the potatoes being used as a renovating crop to get the land in shape to be reseeded to alfalfa.

Yields.—In the southern or early potato districts yields vary from 35 to 125 standard 3-bushel barrels to an acre. Fifty-five to sixty-five barrels of No. 1 grade and 15 to 18 barrels of No. 2 grade are considered good yields. The average yield of late potatoes for the United States in 1924 was 124.2 bushels per acre, but the average for the five-year period ended with 1924 was 107.8 bushels to the acre. The use of certified seed and seed treatment has helped to increase the yields from 25 to 45 bushels per acre. The seed required to plant 1 acre varies according to size and variety from 9 to 15 bushels.

Radish.—Plant in hotbeds or coldframes for early production. Plant in the open ground as soon as the soil can be worked. Plant in rows 12 to 18 inches apart and thin to 2 or 3 inches in the row. The quantity of seed required is 1 ounce to 100 feet of row, or 12 to 15 pounds per acre with rows 15 inches apart. Earliest

varieties sometimes are ready for use in 14 to 16 days after being planted. Two or three plantings should be made during early spring, to provide a continuous supply. Winter radishes may be sown late in the season and stored for winter use. The leading varieties are Early Scarlet Globe, Early Scarlet Globe White Tip, French Breakfast, Early Long Scarlet Top, Improved Chartier, Lady Finger, and White Strasburg. Among the winter or storage varieties are White Chinese, Chinese Rose Winter, Long Black Spanish Winter, and Round Black Spanish Winter.

Turnip.—Requires a rich soil and may be grown either as an early or a late crop. The best yields are made when turnips are planted to follow some early crop that has been heavily fertilized. Light clay loams and rich sandy loams give heaviest yields. The quantity of seed required for an acre drilled is 1 to 2 pounds, but is 2 to 4 pounds for broadcasting. Common varieties of turnips, also the Seven-Top turnip, are planted in the fall throughout the South, and the tops are used during the winter and early spring for greens. Purple-Top Strap Leaf and other common varieties of turnips are grown in the South as an early spring crop, the roots being used while young and tender. In the North turnips are grown mainly as late summer and fall crops, and the roots are stored for winter use. Plant broadcast after early potatoes or peas, or plant in drills 12 to 18 inches apart. Usually planted about July 25, but may be planted as late as September 1 in many sections. Yields vary from 200 to 600 bushels per acre, occasionally 800 to 1,000 bushels. Turnips are not injured by light freezing, but should be pulled, the tops cut off, and the roots stored in pits or cool cellars before hard freezing occurs. Varieties of turnips commonly planted are Purple Top White Globe, Purple Top Strap Leaf, Early Milan Purple Top, Golden Ball, Amber Globe, Large White Norfolk, and Long Cow Horn.

Rutabaga.—The rutabaga, of which there are several varieties, is a form of turnip which is largely grown in the extreme northern sections for winter storage, being marketed during the late winter and early spring. The flesh is crisp and tender, and retains its flavor until well into spring. Stored like turnips in pits, or in specially constructed cellars.

Salsify.—Plant rather early in the spring for northern sections and grow the same as carrots and parsnips. In the South salsify may be grown either as an early spring or as a fall crop. The late crop may remain in the ground until needed for use, or the roots may be dug and stored in pits or in a cold cellar. When stored in a cellar the roots should be packed in moist sand. The roots grow to a length of 12 to 15 inches, and the crop should be grown on deeply prepared, mellow, rich soil. Sow in drills 15 to 18 inches apart for hand cultivation, and 24 to 36 inches apart for horse cultivation. Thin to 4 or 5 inches in the row. Mammoth Sandwich Island is the most common variety. Plant 1 ounce of seed for each 100 feet of row, and 5 to 8 pounds of seed to an acre, according to the distance between rows. The uses of salsify are similar to those of parsnips. When boiled and afterwards coated with rolled crackers and fried in butter it has a decided oyster flavor, from which the name "vegetable oyster" is derived.

Sweet Potato—*General.*—Grown for the market in about 27 States and for home use in 12 to 15 additional States. The average yield per acre is about 97 bushels. The sweet potato is of a tropical nature and succeeds best in the warm, sandy, loamy soils of the Southern States.

Planting.—From 8,000 to 11,000 slips are required to plant an acre. These slips are grown from small, uniform, disease-free potatoes saved over from the previous crop and are produced, as a rule, by the use of hotbeds or fire-heated pits. Plant on beds or ridges after all danger of frost is past, either by hand or with machine, preferably with machine, applying about a pint of water with each plant. Sweet-potato planting machines are the same as those used for setting tobacco.

Fertilizers.—From 200 to 800 pounds of commercial fertilizer are used, although some growers use from 1,200 to 1,400 pounds. The fertilizer generally contains about 3 per cent nitrogen, 8 per cent phosphoric acid, and 5 or 6 per cent potash. It is placed under the row and mixed with the soil.

Cultivation.—Riding cultivators with small teeth that will work close to the plants are used during the early part of the season. Later, when the vines begin to run, larger shovels are used. Frequently the vines are turned and the soil thrown to the ridges, either with a one-horse turnplow or with a hilling device.

Storage.—Dig before or immediately after the frost kills the vines. Losses in storage may be avoided by careful handling, freedom from disease, curing in a storage house at a temperature of 85° to 95° F. with plenty of ventilation and by holding a temperature of about 50° after the curing period. The sweet potatoes should not be disturbed while in storage.

Shipping containers.—The early sweet-potato crop of Virginia is shipped in standard 100-quart veneer stave barrels having burlap covers. Hampers holding one-half bushel, five-eighths bushel, and 1 bushel are used by the New Jersey growers. Crates holding 1 bushel are used largely by the southern growers. One-bushel hampers are becoming popular as shipping containers for fancy sweet potatoes.

Miscellaneous—*Celeriac.*—Large-rooted form of celery, used for cooking only. Cultivate the same as celery, but banking or blanching is not required. The roots may remain in the ground until wanted for use, provided a light covering is applied to prevent freezing.

Chufa.—Produces an abundance of small, cylindrical, underground tubers. The tubers or nuts are much relished by hogs, and the crop usually is harvested by their being turned onto the field. When cultivated the nut has a fine flavor if properly dried. The crop does best on sandy soil that has been well fertilized. Heavy soils should be avoided. Plant in early spring about 2 inches deep, in rows 2 to 4 feet apart, and set the tubers 12 to 15 inches in the row. The crop ripens in October or November.

Dasheen.—Fall-maturing crop grown in the South and used to supplement the supply of home-grown potatoes. Requires a rich, loamy soil, an abundance of moisture together with good drainage, and a fairly moist atmosphere. Plant two weeks or more before the last spring frost is expected. For field culture tubers or small corns are planted whole and singly, not more than 2 or 3 inches deep. It is recommended that dasheens be planted in 3½ or 4 foot rows, about 2 feet apart in the row. When harvested the dasheen is turned over with a 10-inch plow. After being turned out the clumps are broken apart, most of the soil shaken from the roots, and the plants usually left on the ground to dry for one to three days before the tops and roots are removed. Cleaning and grading are done on a bench in the field. The dasheens, with the

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clumps broken apart and the tops cut off, are brought to the bench in field crates. Stored successfully at 50° F. with ventilation.

Jerusalem artichoke.—Will grow in any good garden soil. It should be planted 3 to 4 feet apart each way, with three or four small tubers in a hill. If large tubers are used for planting they should be cut like potatoes. Plant as soon as the ground becomes warm in the spring, and cultivate as for corn. A pint of tubers cut to eyes will plant about 30 hills. The tubers will be ready for use in October, but may remain in the ground and be dug at any time during the winter. The tubers are prepared by boiling until soft, and are served with butter or creamed. May also be used for salads and pickles.

Stachys.—Belongs to the mint family. It produces, just below the ground, a multitude of small, white, crisp, edible tubers, varying from 1 inch to 2½ inches in length, about half an inch in thickness, and marked by irregular constrictions which give them a beadlike appearance. Easy to cultivate and pleasant in taste. The flavor resembles that of the Jerusalem artichoke. Should be stored in sand or sawdust. They are ready for use when the plant dies down in the fall, though they may be easily carried over winter. They are prepared for the table like potatoes or other vegetables, or may be eaten raw like radishes.

Bulbous Crops

General.—The crops belonging to this group are universally planted in the home and market garden and are adapted to growing on any good garden soil. They are also valuable for their mineral content and for seasoning purposes.

Chive.—Small onionlike plant having flat, hollow leaves which are used for flavoring soups. It rarely forms seeds and is propagated by the bulbs, which grow in clusters. The leaves may be cut freely and soon are replaced by others.

Welsh Onion (Cibol).—(See .325.)

Garlic.—Grown for the market in a comparatively few localities in the United States. Requires a deep, rich soil, but land should not be manured immediately before being planted to garlic. Propagation is by small bulblets or cloves of which the mother bulb is composed. Planted in rows 24 to 30 inches apart, and the cloves are spaced about 5 inches in the row. Bulblets or cloves planted in early spring on rich land will produce marketable bulbs by fall. Garlic bulbs are harvested before the tops completely die down, and are prepared for the market by having their tops plaited together so as to form a rope about 3 feet in length. This is hung in a well-ventilated, shady place to dry. Garlic is sold by the string, but more often by the pound. Yields of 8,000 to 10,000 pounds to the acre are sometimes procured.

Leek.—Form of onion, which is grown for its thick, fleshy stem, but does not form a true bulb, as does the onion. The seeds are sown in rows 15 to 24 inches apart. May be grown in a seed bed and transplanted to the rows. Thin the plants to stand 3 to 6 inches in the row. Grown the same as onions, except that they are planted rather deeply and the soil is banked up to the plants in order to produce a well-bleached stem about an inch in diameter and 6 to 8 inches in length.

Onion—*General.*—The onion in its various forms is perhaps the most universally grown garden crop in the United States, and is found in practically every home garden and in most market gardens. The commercial

crop is produced in certain well-defined sections and on special types of soil, such as the muck lands of the Great Lakes region. Several types or varieties of onions are included in the standard or northern crop, such as Yellow Globe, Yellow Globe Danvers, Prizetaker, Red Globe, Australian Brown, Japanese, White Globe, and Silver Skin. Among the special groups are the Bermudas, including Red Bermuda, White or Yellow Bermuda, and Crystal Wax; also such special varieties as Giant White Tripoli and White Portugal. In addition there are the multipliers, including the so-called potato onion, which multiplies by division of the bulbs, and the "top" multipliers, which multiply by forming sets on the tops where the seed is usually borne.

Planting.—A large part of the onions grown in home gardens is planted from sets, which were produced the year previous by a special method of seeding heavily and growing the bulblets crowded closely in order to stunt their growth. These bulblets or sets are dug in July, when they are about one-half to five-eighths inch in diameter, are cured in cool, well-ventilated buildings through the winter, and are reset in the spring to form large onions. A small percentage of the commercial crop is grown from sets, but the bulk is grown from seed, commonly referred to as "black seed," which is sown directly in the drills where the onions are to be grown. Four to six pounds of seed are used for planting an acre by this method. The rows are spaced 14 to 18 inches apart. Seed should be sown as early in the spring as the seed bed can be prepared. Difficulty is often experienced on the muck or light sandy soils because the surface blows off and completely uncovers the seed or young plants. Windbreaks, consisting of strips of rye, or sometimes permanent hedges of California privet, are used to protect the lighter lands from blowing. The blowing can also be controlled by irrigation.

In southwestern Texas, where the Bermuda onions are largely grown, the seed is planted in October in specially prepared seed beds. The seedlings, when about the diameter of a wheat straw, are lifted and reset in the beds where they are to grow. In these field beds the rows are spaced 12 to 18 inches apart and follow the contour of the beds, which are leveled for flood irrigation. The onions are set in the field beds during the latter half of November and the early part of December, and they mature from March 15 to May 10. Three and one-half to four pounds of seed are required to grow enough plants with which to set an acre, this seed being grown in the Teneriffe Islands.

Fertilizers.—Requirements for onions vary with the soil conditions, but as a rule from 800 to 1,400 pounds of a fertilizer containing 3 to 5 per cent of nitrogen, 8 per cent phosphoric acid, and 5 to 6 per cent potash is used per acre, the fertilizer being sown broadcast and mixed with the soil during the preparation for planting.

Harvesting.—Yields of onions vary from 200 to 800, and occasionally to 1,000 bushels to the acre. From 400 to 500 bushels per acre is considered a good yield. Onions, after being pulled from the soil, should be dried for a day or two. The tops should then be removed by being cut with sheep shears or knives, and the bulbs may be placed in crates or loosely woven bags protected from the direct sunlight but given plenty of ventilation until thoroughly dry.

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Storage.—Onions should be stored in well-ventilated, cool storage houses, but are injured by freezing. The freezing temperature for onions is about 30° F., but they are not injured by lower temperatures for short periods.

Shallots.—Grown very much the same as chives, but the bulbs are used instead of the leaves.

Greens and Salad Crops

General.—In mineral and vitamin content this group stands at the head of our vegetables. Adapted to growing over a large range of territory and on a wide variety of soils. Commercial production is highly specialized in a number of definite areas.

Celery—*General.*—Adapted for growing throughout the greater part of the United States, but its market production is confined mainly to a few definite areas, especially California, Florida, the Great Lakes region, and the New England States. Requires a deep, rich, moist soil that is well drained, particularly on the muck lands of the Great Lakes region and on the hammock lands of Florida.

Planting.—In the North sow the seed in a hotbed or coldframe and transplant to the open ground. Celery plants are generally improved by being transplanted twice. Seeds are very small and are slow in germinating, and the temperature of the seed bed should be kept low. The quantity of seed required to plant 1 acre is 2 to 4 ounces. Number of seeds in an ounce is about 70,000. Number of plants required is 27,000 to 60,000 per acre, according to planting distances and arrangement of plants. Most common planting distances are 30 to 36 inches between rows and the plants 6 inches apart in the rows; also 36 inches between rows and plants set in double rows 6 inches apart. After the plants are up care should be taken that the bed does not become too wet and the plants damp off.

Fertilizers.—Include rotted stable manure, especially on the loams and sandy uplands, and commercial fertilizer containing 4 to 7 per cent nitrogen, 8 to 10 per cent phosphoric acid, and 4 to 6 per cent potash, used in quantities varying from 1,000 to 4,000 pounds per acre.

Varieties.—Leading varieties are Golden Self Bleaching, Golden Plume, Easy Bleaching, and Giant Pascal.

Bleaching.—Bleached by means of boards 10 to 12 inches in width and 1 inch thick held in place by stakes or wire spanners. During recent years special paper, made in strips 10 to 12 inches wide and about 300 feet in length, has been used for bleaching celery. This paper is held in place by either light stakes or wire arches.

Shipping containers.—Standard celery crate, old type, is 24 by 24 by 20 inches. New type is 24 by 20 by 16 inches. Florida crate is 24 by 20 by 11 inches. Number of standard crates produced per acre is 300 to 500. Number of Florida crates produced per acre is 400 to 900. Celery freezes in storage at 30.6° F.

Dandelion.—Sow the seed in spring in drills 18 inches apart, covering it one-half inch deep. Thin the plants to about 12 inches apart and give good clean cultivation throughout the summer. Seed sown in coldframes in the fall and slightly protected by a sash over winter will give a heavy growth of greens during early spring. Leaves may be bleached by the spreading of a light covering of straw over the plants for a few days, or placing of straw mats on top of the sash to darken the interior of the frame. This not only makes the leaves more tender but destroys a part of the bitter taste. The greater part of dandelion greens is marketed without being bleached. Sold by the pound or by the hamper.

Endive.—Relative of chicory. Sow the seed thinly in drills, and when the plants are well established thin to 8 inches. Water and cultivate thoroughly in order that a good growth of leaves may be made. When the leaves are 6 to 8 inches in length draw them together and tie them so that the heart will blanch. The leaves should not be tied while wet, or decay will follow. The heads should be used as soon as blanched. For winter use sow the seed rather late and remove the plants, with a ball of earth adhering to the roots, to a cellar or coldframe, and blanch during the winter as required for use. Endive is used as a salad at times of the year when lettuce and similar crops are out of season.

Kale.—Grown extensively for the market throughout the South and middle Southern States, especially along the Atlantic seaboard. Seed is planted in the fall in beds or ridges and thinned so that the plants stand 8 to 12 inches apart. May be set in rows and cultivated the same as cabbage, or may be sown broadcast, but set somewhat closer. Seed is sown by means of a seed drill, either in a continuous row or checked in hills about 12 inches apart. Fertilize the same as for cabbage, distributing the greater part of the fertilizer during the preparation of the seed bed. The usual custom is to mark the rows, sow the fertilizer, then bed over it. Kale is cut and marketed at any time during the winter when the ground is free from snow and the plants are in good, tender condition. Shipped in barrels that have burlap covers, in crates, in 1-bushel baskets, or in hampers. The flavor is improved by frost. Kale is used for greens during the winter, being a substitute for cabbage.

Lettuce—*General.*—Grown extensively for carload shipment in the Imperial Valley, Colorado, Arizona, Idaho, Florida, southern Texas, the Carolinas, Great Lakes region, and in the New England States. Attains its best development in a rich, sandy loam in which there is plenty of organic matter. It thrives best during the early spring or late fall, and will not withstand the heat of summer.

Planting.—Usual planting distance in the open ground is rows 15 inches apart and plants 8 to 12 inches apart in the row. Quantity of seed required is 1½ to 2 pounds to the acre. Plants may be grown in beds and transplanted to the field, or may be seeded in place and thinned. In order to produce crisp and tender lettuce during the summer months it may be necessary to provide some form of partial shading.

Fertilizer.—Is scattered broadcast while the seed bed is being prepared and is thoroughly mixed with the soil.

Varieties.—Varieties most commonly planted are Big Boston, Iceberg, New York, and May King for outdoor growing, and Grand Rapids, May King, Rawson's Hothouse, and Hittinger's Belmont for greenhouse culture.

Shipping containers.—Standard lettuce crate of the East holds 2 dozen heads and that used in the west 4 dozen. One bushel and one and one-half bushel hampers are frequently used. California growers use crates 18 by 18 by 24 inches in size for shipping Iceberg lettuce.

Mustard.—Almost any good soil will produce a crop of mustard. The basal leaves are used for greens, and as the plants require but a short time to reach the proper stage for use, frequent sowings should be made. Sow the seeds thickly in drills as early as possible in the spring, or for late use sow the seeds in September or October. The forms of Chinese mustard, of which the leaves are often curled and frilled, are generally used. Mustard greens are cooked like spinach.

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Spinach.—Grown largely for the market in southern Texas, in the Gulf coast region, and along the Atlantic coast, especially from Charleston northward. To produce good spinach a rich loam which will give the plants a quick growth is required. As ordinarily grown, spinach occupies the land during the fall and winter only and does not interfere with summer cultivation. In the Norfolk region a disease-resistant strain of seed is used and is planted during October and November at the rate of 12 to 15 pounds of seed to the acre. Usually planted in beds 5 to 7 feet in width, in four or five rows to the bed. The seed is planted by means of "gang" seed drills drawn by mules or horses. In the North it may be planted in early spring, or it may be planted in the fall and carried over winter by mulching with straw or leaves. Sow the seed of spinach in drills 1 foot apart at the rate of 1 ounce to 100 feet of row, or 10 to 12 pounds per acre. Requires heavy applications of fertilizer, which usually contains 4 to 5 per cent nitrogen, 8 per cent phosphoric acid, and 3 or 4 per cent potash. The greater part is applied while the seed bed is being prepared. Spinach is marketed during the fall, throughout the winter and spring, and well into the summer. The plant is harvested by cutting the root at the surface of the soil. The larger plants are selected first, and the smaller or later ones are thus given room to develop. The leading varieties are Bloomdale Savoy, Norfolk Savoy, Curled Savoy, and Long Standing. Shipped in veneer stave barrels having burlap covers, in hampers, 1-bushel baskets, and in crates.

Miscellaneous—*New Zealand spinach.*—Not a true spinach, but grows much larger and should be planted in rows 3 feet apart, the plants 12 to 18 inches apart in the row. Soak the seed one or two hours in hot water before planting, in order to insure germination. When started early in the spring it resists hot weather to a much greater degree than does ordinary spinach, and thus is better adapted for growing during the summer months. The fleshy leaves and tender stems are cooked the same as spinach.

Parsley.—After the seeds have been soaked for a few hours in warm water they may be sown during the fall or winter in coldframes and hotbeds, and may be transplanted to other frames or to the open ground. In the North parsley will live over winter in a coldframe or pit, and in the South it will thrive in the open during the winter, but it can not withstand the heat of summer. Set the plants in rows 12 inches apart and every 4 inches in the row. For marketing parsley remove the leaves, tie them in small bunches, and ship in either barrels or hampers. Used for garnishing meats and for flavoring soups.

Peppergrass or cress.—There are two forms of cress, the water cress and the garden cress. The garden cress, sometimes called peppergrass, is grown easily from seed sown in drills a foot apart. Since the plants last but a short time, it will be necessary to sow every few days if a continuous supply is desired. May be grown in frames or in the open. Water cress can be grown all the year in small, open ditches containing running spring water. It is best and most easily produced in water from rather warm springs in limestone regions. A sufficient supply for family use can be grown in a small spring-fed brook, and the plants may be started either from small pieces of plants or from seed. Used in salads, to which it imparts a pleasant pungency.

Sorrel.—Sometimes called sour grass. Seed is sown in drills about 15 inches apart. Resembles the weed

"sour dock" of the fields. The leaves are large, tender, and juicy, very broad, and often 10 inches long, retaining the pleasant acid flavor of the original weed. Leaves are cut and used the same as spinach.

Swiss chard.—Chard, or Swiss chard, is a beet which is grown for its foliage instead of its root, but it does not form any enlarged root as does the beet. If sown in early spring it will yield an abundance of fresh greens for use during the summer months. Planted about the same time and in the same manner as beets, but, as the top grows larger, it should be given more space than the garden beet. At first thinnings are made so that the plants stand 4 to 6 inches apart in the rows; later the individual leaf stems are removed and the plants allowed to continue to produce a fresh supply of leaves. The leaves are cooked and used like spinach, as a potherb or greens. The thickened leaf stem is sometimes cooked and used in much the same way as asparagus. Crop after crop of leaves may be cut without injuring the plant. Excellent as a green food for poultry.

Cabbage Crops

General.—This group is highly important for its mineral salts and vitamin content. Crops of this group, with the possible exception of cauliflower, broccoli, and Brussels sprouts, are produced for the markets only in certain well-defined areas.

Broccoli.—Variety of cauliflower that is more commonly grown for fall use, as it is rather more hardy than the true cauliflower. Grown mainly in the Pacific Northwest near the coast. There is a general misunderstanding regarding the cauliflower and broccoli. Both are the same in general make-up and growth, producing heads in the same manner, and by the casual observer being taken one for the other. The difference is that the cauliflower is a more tender and a quicker-maturing variety, and therefore will not stand a very low temperature. The seed is sown in early spring and will produce heads during the summer. The broccoli will stand a temperature as low as 25° F. without much injury to the plant. Seed is sown in the spring. Plants are set out in May or early in June and continue to grow until the following spring, some varieties producing heads at intervals during winter and up to as late as May. Seed may be sown and the plants treated in every way as for cabbage.

Brussels Sprouts.—Similar to cabbage, except that the plant does not form a central head but has numerous small buttons or heads along the stems in the axils of the leaves. As the heads begin to crowd, the leaves should be broken from the stem of the plant, so that the heads will have more room. A few leaves should be left at the top of the stem where the new heads are being formed. Culture is the same as for cabbage, although Brussels sprouts are adapted to growing only in the warmer parts of the country. For winter use in cold localities take up plants that are well laden with heads and set them close together in a pit, coldframe, or cellar, with a little soil around the roots. For shipping pack them in quart berry boxes and place in regular berry crates, which hold 32 boxes. Brussels sprouts are used like cabbage, but are considered to be of superior flavor.

Cabbage—*General.*—Three phases of the cabbage industry are (1) the early or southern crop, (2) the late or northern storage crop, and (3) the crop for sauerkraut making. A rich, well-drained soil of almost any character will grow cabbage. Good cornland and wheatland heavily

manured for the corn crop preceding cabbage will give best results.

Planting.—Seed from which to grow the southern or early crop should be sown about October 10 in the latitude of Charleston, S. C., and the plants set in the fields during late November and early December. The ground should be ridged and the plants set either on top of or on the side of the ridge. When set in the spring the seed should be started in a hotbed or greenhouse in February and in the open ground as soon as the soil can be worked. For a late crop in the North plant the seed in a bed in the open ground in April or May and transplant to the garden in June or July. Set plants in rows 30 to 36 inches apart and 14 to 18 inches apart in the row.

Fertilizers.—Commercial fertilizers containing 4 to 5 per cent nitrogen, 8 to 10 per cent phosphoric acid, and 3 to 6 per cent potash are used in quantities varying from 400 to 1,000 pounds to the acre on the standard or northern crop. For the southern early crop growers usually apply 1 ton to the acre of a fertilizer containing 4 to 5 per cent nitrogen, 8 to 10 per cent phosphoric acid, and 4 to 5 per cent of potash.

Varieties.—The varieties used for the early crop are Jersey Wakefield, Charleston Wakefield, Copenhagen Market, and Golden Acre and for the standard or late crop Danish Ball Head, All Seasons, Savoy, and Late Flat Dutch.

Storage.—Late cabbage may be kept in storage houses, banks, or pits, or in trenches surrounded with poles, banked with dirt, and covered over the top with straw.

Shipping containers.—The early cabbage crop is shipped in hampers, in crates, and in open-stave barrels having burlap covers. The late crop is sometimes shipped in barrels and bags, but usually in bulk. Cabbage for sauerkraut making is grown in the vicinity of the factories and hauled directly from the fields to the factory.

Cauliflower.—Adapted for cultivation only in restricted areas, mainly near the seacoast. The leading producing sections are Long Island, northern New Jersey, New York, Connecticut, Massachusetts, and California. Requires a rich, moist soil, and thrives best under irrigation. It will not withstand as much frost as cabbage. Culture is the same as for cabbage until the heads begin to develop; the leaves then should be tied together over the heads in order to exclude the light and to keep the heads white. The varieties are Dwarf Erfurt and Early Snowball.

Chinese Cabbage.—Closely related to the turnip. Makes a head of erect leaves, which is stemless and rests on the ground. It is often listed by seedsmen as Pai T'sai or Petsay, which are forms of its Chinese name, Pe-tsai. Grown in the same manner as lettuce, but the plants should stand at least 24 inches apart in the row. The plant demands very rich, well-drained soil, but must not be allowed to suffer from lack of moisture. Start the seed in a seed bed and transplant when the plants are very small. Plant in the early spring and mature before hot weather, or plant in the late summer and mature in the fall. The heads as a rule are about 4 or 5 inches in diameter and 8 to 10 inches in height. For marketing the heads are cut just above the ground, a few of the outer leaves removed, and the heads packed in crates in the same manner as lettuce. The plant may be used as a potherb, like kale or spinach, or when headed it is a fine salad plant, being more tender when cut up than ordinary cabbage.

Collards.—Grown extensively in the Southern States. Culture and uses are the same as for cabbage and kale. Collards withstand the heat better than either cabbage or kale, and a type known as Georgia collards is highly esteemed in the South. They do not form a true head, but instead a loose rosette of leaves, which when blanched are very tender and of delicate flavor. Planted during the late summer the same as late cabbage, but allowed to stand where grown until used.

Kohl-Rabi.—Belongs to the same class as cabbage and cauliflower, but presents a marked variation from either. The edible portion consists of the swollen stem of the plant. For an early crop, plant and cultivate the same as for early cabbage. For a late crop, or for all seasons in the South, the seed may be sown in drills where the crop is to be grown and thinned to about 8 inches apart in the row. The rows should be from 18 to 35 inches apart, according to the kind of culture used. The fleshy stems should be used while they are young and tender.

Beans and Peas

General.—Table beans are for the most part of American origin, but all our peas were brought from Europe. Crops of this group are widely distributed, and some are grown in practically every home and market garden in the United States. Beans will not withstand much cold, so they should not be planted until danger of frost is past and the ground begins to warm. The first planting should be made as soon as the ground is reasonably warm, and other plantings may be made at intervals of 10 days or two weeks until hot weather sets in. Beans for the fall garden should be planted in late summer, and successive plantings may be made at the intervals suggested until about eight weeks before the time for the first frost in fall. Peas not only withstand considerable cold, but in addition are a short-season crop and have a still greater range of adaptability. Within the group are varieties and types which fit almost every condition.

Broad Bean.—Introduced from Europe, and is grown for its grain or seed, which is used as food for man and for likestock. Grown to a small extent in gardens, especially in sections of the country where the early summer is cool and moist. It is adapted to the northern Pacific coast. When grown for seed it is commonly sown with a grain drill in rows 28 to 35 inches apart. May be hand-planted. Plants should stand about 2 inches apart in the row. Quantity of seed required is 40 to 50 pounds per acre. When grown for silage, fodder, or green manure, broad bean should be sown in rows 21 inches apart at the rate of 50 to 60 pounds per acre. It is planted in gardens only by growers who are accustomed to its culture and use. Will not set pods in hot weather and must be planted early to succeed.

Kidney Bean.—Native of America, and includes all our common field and garden beans.

Field bean.—Includes all varieties of the kidney type grown as a farm or field crop for dry beans. Culture is the same as for garden beans, except that rows are spaced for cultivation with riding cultivators and other implements, such as are used for cultivating corn. Three pecks to 1 bushel of seed is required to plant 1 acre, according to variety and size of individual seeds. Yield of dry beans is 12 to 20 bushels per acre. Harvested with a regular bean harvester, which cuts off the plants at the

surface of the ground and bunches the tops. Beans are separated from vines and pods by special bean threshers. Principal producing territory located in California, Michigan, Idaho, and New York.

Garden bean.—This group includes the bush-type green pod, bush-type wax pod, pole-type green pod, and pole-type wax pod. Usually referred to as string beans or snap beans. Both the bush and pole types are grown in home gardens, but the bush type is grown extensively in the Southern States as an early truck crop for the northern markets. The early crop is generally planted on well-drained and warm sandy loam. About 1 ton of 4–8–4 or 5–10–5 fertilizer is spread broadcast and worked into the soil before planting. One bushel of seed will plant an acre if care is used in distribution of seed. Planting distances are usually 30 to 36 inches between the rows and 12 inches between hills in the rows. Stringless Green Pod, Early Red Valentine, Early Black Valentine, and Wardwell's Kidney Wax are among the varieties commonly grown for the early market. Shipping containers are half-bushel hampers, 1-bushel baskets, and 1-bushel crates.

Lima Bean.—Both the bush and the pole type usually are grown in the garden. Give best results on good clay-loam soils, such as will grow wheat or clover. Plant after all danger of frost is over and when the soil is warm. Plant the pole beans 8 to 10 seeds in a hill, and thin to 3 or 4 after the plants become established. The hills should be 4 or 5 feet apart. Pole Lima beans may be planted along the garden fence and the vines allowed to utilize the fence as a support. Plant bush Lima beans 5 or 6 inches apart in rows 30 to 36 inches apart. When beans of any kind are planted the seed should not be covered by more than 2 inches of soil and in heavy soils by not more than 1¼ to 1½ inches. Pole varieties may also be planted 3 by 4 feet apart, 2 plants to a pole. Number of poles required per acre is 3,620. Commercial fertilizers are used at the rate of 1,000 pounds per acre. Leading varieties of pole Lima beans are King of the Garden, Challenger, and Early Leviathan for the North, and the small white Lima or "Sieva" for the South. The leading varieties of the bush Lima beans for the North are Fordhook Bush Lima, Burpee's Improved, and Henderson Bush, and for the South, Henderson Bush.

Yard-Long Bean.—Known as the asparagus or French yard-long bean. The other member of the Dolichos group of beans is the hyacinth bean. Vines of the yard-long bean produce very long, slender pods and small, narrow beans. It is a native of tropical America.

Soy Beans.—(See 10.428.)

Scarlet Runner.—Strong-growing climbing plant, used for decorative purposes on account of its clusters of bright blossoms, which give it an ornamental value of no mean significance.

Cowpea.—(See 10.424.)

Field Peas.—(See 10.425.) This group includes all the peas grown as a farm crop, mainly for the canneries, from the standpoint of the discussion of the subject at this place in the handbook. Soil required is well-drained land, such as will grow good crops of wheat and clover. Commercial fertilizers sometimes are used at the rate of 400 to 800 pounds to the acre. Land plowed, harrowed, and smoothed before planting. Seed sown broadcast or with special drill, like wheat drill, as early as the soil can be worked. Quantity of seed required is 4 to 5 bushels per acre. Variety used is known as Alaska, or some strain of Alaska, the yield being about 1 ton of shelled peas per acre. Peas for the cannery are harvested with a mowing machine, usually having a vine

buncher attached to the cutting bar. Vines are hauled on hay racks to a centrally located viner, which removes and grades the peas.

Garden Peas.—Three types are grown, namely, smooth peas, of which the variety known as Alaska is the type; wrinkled peas, including all such varieties as Gradus, Thomas Laxton, Laxtonian, and Telephone; and edible-podded, of which Mammoth Podded Sugar is the type. Garden peas, sometimes called English peas, are not injured by light frosts, and should be planted as soon as the soil can be worked. The first plantings should be of small-growing, quick-maturing varieties which do not require supports. Follow these varieties with the large wrinkled type of peas. The large-growing varieties should be supported on brush, on strings attached to stakes driven in the ground, or on wire netting. To have a continuous supply of peas, plant every 10 days or two weeks until warm weather begins. Plant in late summer or early fall for the fall garden, for which the early varieties are more desirable than the late ones. Plant 10 seeds to the foot, 2 or 3 inches deep, in rows 30 to 36 inches apart. One quart of seed will plant 150 feet of row. Some growers prefer to plant in double rows 6 inches apart and leave the ordinary space between these pairs of rows.

Vine Crops

General.—Vine crops are adapted to growing under a wide range of soil and climatic conditions, but attain their best development where they receive abundant heat and sunshine and an average amount of rainfall. Crops like the Casaba and Honeydew melons are natives of the hottest parts of the globe, whereas certain pumpkins and squashes thrive in the more northern sections. As a whole, vine crops thrive on well-drained sandy or loamy soils, such as are found in delta and river-valley regions. During recent years muskmelons, watermelons, and cucumbers have been highly specialized as commercial shipping crops, and are being produced on a large scale in certain sections of the country.

Chayote.—Adapted for growing in southern California, the lower Gulf coast region, and in Florida. The chayote suggests the cucumber rather than any other of the cultivated plants of the same family, but it is a larger and more vigorous plant, climbing widely by means of numerous branched tendrils. Can be grown wherever the ground does not freeze in winter. Grown like cucumber, but should have supports. Propagated by planting the entire fruit in the early spring. Plants should be spaced 10 feet apart, and a single plant will produce 100 fruits under favorable conditions. The fruit is cooked as a vegetable, creamed, baked, or made into fritters, or is used like potatoes and squash. May be stored two or three months in a cool place.

Citron.—Grown the same as watermelons, but requires less care and cultivation. The fruit is a type of watermelon, usually round, solid, the flesh remaining green and not ripening like the watermelon. Flesh is used for making preserves and sweet pickles; also for stock feeding. Not the true citron from which the preserved citron of commerce is made.

Cucumber—*General.*—Grown on a large scale in Florida, Texas, and other Southern States for shipment to the northern markets. Requires a rich soil.

Planting.—Easily injured by cold, so do not plant until all danger of frost is over and the ground has begun to

warm. For early cucumbers plant the seeds in a hotbed in old strawberry boxes, plant bands, inverted sods, or directly in the soil of the bed. If the plants are started in hotbeds the cucumbers will be ready for the table two or three weeks earlier than if started in the open. For the main crop the rows are usually spaced 8 to 10 feet and the plants thinned to stand about 30 inches apart in the row. When seeds are planted in hills the rows are spaced 8 to 10 feet apart and the hills 5 to 8 feet apart in the rows, 2 to 3 plants being left in each hill. As a rule, about 7 seeds are planted in each hill and the plants thinned first to 4 in a hill, and later to the desired number. One to two pounds of seed required to plant an acre.

Cultivation.—Give frequent shallow cultivation until the vines fill most of the space between the rows. After this very little attention will be needed, except to pull the weeds by hand. Do not allow any fruit to ripen on the vines until the end of the picking season, as new fruits will not form while the older ones are ripening.

Fertilizers.—From 1,000 pounds to 1 ton of a complete fertilizer of about a 4–8–4 mixture is applied to the acre. If well-rotted manure is used it should be applied under the rows or hills. If seeds are planted in rows, open the furrow and scatter the manure along the furrow, turning fresh soil over the manure before planting the seeds. If seeds are planted in hills confine the application to the area occupied by the hills.

Varieties.—White Spine, or some form of White Spine, is used almost exclusively.

Pickles.—Cucumbers for pickles are grown on a large scale in a few well-defined but restricted areas. For this purpose one of the regular pickling varieties, such as Chicago Pickling, Green Prolific, and Jersey Pickling is planted. Production should not be encouraged except in localities where contracts can be made with the operators of salting stations.

Shipping containers.—The cucumbers, or "cukes," as they are called, are gathered in baskets and hauled to the packing shed, where they are graded and packed in half-bushel and 1-bushel hampers, and in barrels.

Gourd.—Grown in gardens both as food and as an ornamental plant. May be grown throughout the entire country, but should be planted where it will have a trellis or some other support to climb upon. Only the very young and tender gourds are suitable for food. Prepared for the table in the same manner as summer squash. One of the most common varieties is the Indian Club gourd, which may attain a length of 4 or 5 feet. The Snake gourd is a species that is frequently grown.

Muskmelon (Cantaloupe).—Culture is the same as for cucumbers, except that the plants usually are given more space. Muskmelons require a well-drained soil, preferably sandy, although good crops can be grown on clay loam and alluvial soils. The usual planting distances are 5 to 8 feet between rows and 5 to 7 feet between hills. One pound of seed is sufficient to plant an acre at seven seeds to the hill, but growers usually provide 2 pounds to the acre for safety in replanting. Thin first to three plants in the hill and later to two plants. Commercial fertilizer required is 200 to 800 pounds of 4–8–4 or 4–8–3 mixture. Stable or barnyard manure may be used, provided it is well rotted. Leading commercial varieties of muskmelon are Netted Gem (Rocky Ford), Pollock 25, Pollock 10–25, Early Knight, Burrell's Gem, Tip Top, and Hearts of Gold.

Pumpkin and Squash.—Included under this heading are all the field pumpkins and garden forms of squashes.

True pumpkins are seldom considered as a garden crop. As a rule they are grown as a field crop for canning purposes, or with corn as a stock feed.

Garden squashes are made up of three distinct species of cucurbita. Among them are forms which have a bush-like growth and others which have a vining habit of growth. None of them should be planted until danger of frost is over and the soil is warm. Care and cultivation are the same as for cucumbers and melons.

The so-called summer squashes, represented by Summer Crookneck, Pattypan, or Scallop, sometimes called "cymlin," are varieties of *Cucurbita pepo*, the same species as the field pumpkin. These are used for food only when young and tender. They may be boiled or fried. The Canada Crookneck, or pie squash, is extensively grown for cooking and pie making. It has a running habit of growth, and is not so desirable for use as a vegetable as either the summer squash or the Hubbard type of squash. It is a variety of *Cucurbita moschata*. The winter squashes, which are most extensively used for baking and boiling, belong to *Cucurbita maxima*, and are represented by the Pike's Peak, Hubbard, and Boston Marrow. Squashes of this species are extensively grown in the general territory in which late potatoes thrive best, and can be stored in frost-proof storage at temperatures ranging from 50° to 60° F.

Watermelon.—Requires well-drained, preferably sandy, soil and a comparatively long season of growth. Usual planting distances are 10 by 12 or 10 by 14 feet each way, and two plants to the hill. Quantity of seed required is 1 pound per acre, unless considerable replanting is necessary. Commercial fertilizer of a 4–8–4 or similar formula is used at the rate of 200 to 1,000 pounds per acre. Usual quantity is about 500 pounds. Manure is used in hills where available. Manure produced by feeding hay grown from old watermelon fields should not be used, on account of a possibility of transmitting disease to the new plants. Cultivation is the same as for cucumbers and muskmelon, except that the plants require more space. Average yield is about 296 marketable melons to the acre. The most important market varieties are Tom Watson, Florida Favorite, Excel, Irish Grey, and Thurmond Grey. Among the best varieties for the home patch are Kleckly Sweet, Florida Favorite, Kolb Gem, and Halbert Honey.

Other Annual Crops

General.—This group includes the vegetable crops that can not be readily classified botanically or otherwise with any other group in the key to the handbook material. Aside from sweet corn and okra, the crops belong to the order Solanaceæ.

Eggplant.—In the middle and northern sections start the plants in hotbeds, then shift to a well-protected coldframe and finally to the field after all danger of frost is past. The usual planting distances are 3 by 3 or 3 by 4 feet. The usual method of planting is to open a double furrow and place a forkful of well-rotted manure in the bottom of the furrow where each plant is to be set. Mix this manure with the soil and set the plants on top of it. Move the plants from the coldframes to the field with a block of earth around the roots and set them deep enough in the furrow to receive some protection from the wind. After they have started active growth work the surplus soil in about the plants. For best results use 20 to 40 tons of manure to the acre during the previous season

and 1,000 to 2,000 pounds of high-grade fertilizer before planting and as a top-dressing. Eggplant is a fairly long-season crop, requiring about 125 days for maturity. The fruits are shipped in bushel crates, hampers, bushel baskets, and sometimes in barrels. Crates similar to a strawberry crate are used in the Norfolk section. Eggplant may be peeled and cut into slices one-fourth to one-half inch thick and soaked in salt and water for an hour, then boiled until tender, and then coated with cracker crumbs or flour and fried in butter or fat. May also be steamed or baked whole and the pulp eaten from the shell with salt, pepper, and butter.

Okra (Gumbo).—Adapted to growing throughout the Southern States. Sow the seeds in the open after the ground has become warm, or start the plants in berry boxes in a hotbed and transplant them to the garden after all danger of frost is past. The rows should be 4 feet apart for the dwarf sorts and 5 feet apart for the tall kinds, with the plants 2 feet apart in the row. Planted and cultivated practically the same as corn. Does best on rather rich land and requires frequent shallow cultivations until the plants cover the ground. The pods are cut while they are still small and tender. The leading varieties are White Velvet, Perkins Long Podded, and Dwarf Green Pod. Shipped to the market in 6-basket tomato crates, in hampers, and sometimes in small crates. High-grade okra is often shipped in quart berry boxes. The young pods are used principally in soups, to which they impart a pleasant flavor and mucilaginous consistency. If the pods are removed from the plants and none allowed to ripen the plants will continue to produce pods until killed by frost, but the best pods are grown from young plants. Okra pod may be dried or canned for winter use.

Peppers.—Two classes are grown extensively for the market—the large, mild-flavored, sweet sorts, and the chili or hot kinds. Among the leading varieties of sweet pepper are Ruby King, Large Bell, Chinese Giant, Neapolitan, and the pimento, the last being used largely for canning. The Red Chili is commonly grown for a hot pepper, although the Long Red Cayenne, Tabasco, and Red Cluster are sometimes used. Sow seeds of peppers in a hotbed or in a box in the house about eight weeks before the time for setting the plants in the garden. The plants are tender and should not be transplanted until the ground is warm and all danger of frost is past. Set the plants 15 to 18 inches apart in rows 3 feet apart. Cultivation is the same as for tomatoes and eggplants. Use barnyard manure the previous season. Apply 1,000 to 2,000 pounds of high-grade fertilizer to the acre, broadcasting a major portion of it while preparing the seed bed, and the remainder as a side dressing during the growing season. The peppers are shipped in 6-basket tomato crates, half-bushel hampers, crates, and bushel baskets.

Physalis.—Known as the ground cherry or husk tomato. Sow the seed in a hotbed or coldframe and transplant to the garden after danger of frost is past. Seeds may also be sown in the row where the plants are to remain and thinned to 12 or 18 inches. No particular care is required, except to keep them free from weeds. Large number of varieties, and the fruits vary in size and color. The most common is the one that produces the bright yellow fruit which is about the size of an ordinary cherry. Toward fall the fruits will drop to the ground and will be protected for some time by their husks. If gathered and put in a cool place, the fruits will keep

for a long time. They are excellent for making preserves and marmalade. In the seed catalogues the physalis will be found listed under "odd" tomatoes. The most prominent varieties are Golden Husk or Winter Cherry and Purple Husk. The Golden Husk has a fine flavor, somewhat resembling that of the strawberry.

Sweet Corn.—Grow on rich land and cultivate the same as field corn. Plant the seed as soon as the soil is warm in the spring, and make successive plantings every two or three weeks until late summer. The same results can be obtained to some extent by planting early, medium, and late varieties. Plant the seed about 2 inches deep in drills 3 feet apart, and thin to a single stalk every 10 to 14 inches. Quantity of seed required is 9 to 14 pounds per acre. Varieties most commonly grown are Golden Bantam, Country Gentleman, Stowell's Evergreen, Howling Mob, Mammoth White Cory, and Mammoth Late Sugar.

Tomato—*Early southern crop.*—Early crop is grown in the extreme South for shipment to northern markets. Seed is sown from October to January in Florida, and plants are set from December to February. In eastern Texas and Mississippi the seed is sown in January or early February. Seedlings are transplanted to coldframes during late February or early March and set in open ground about April 10. Fruit matures from June 1 to July 4. Plants are mostly staked and pruned to a single stem. Tied to 1-inch square stakes or to split stakes about 1 inch in diameter. Soft jute twine, known in the tomato regions as "tomato twine," is used for tying. This twine comes in bales or ropes and can be cut to the desired length. In pruning early tomatoes pinch out all lateral or side shoots with extra care to avoid injuring the blossom clusters. Varieties used are Acme, Globe, Marglobe, Early Detroit, and Bonny Best.

Early northern crop.—Early tomatoes in the North are started in hotbeds and frequently are potted and handled in coldframes. Planted in open ground after frost-free date, usually in rows 4 feet apart and 15 to 18 inches apart in the rows, for training to stakes. Sometimes planted in rows 6 feet apart with double rows of plants 18 by 18 inches. Plants are tied to a stake driven by the side of each plant or to strings tied to overhead wires and fastened to a peg at the base of the plant.

Standard crop.—Plants for the standard tomato crop, both for the market and for canning, are grown in open beds or in coldframes. Plants are usually set 3 by 4 feet. Fertilizers used are well-rotted manure and commercial fertilizer of 4–8–4 mixture, 600 to 1,000 pounds to the acre. The varieties used for the standard crop are Stone, Paragon, John Baer, Greater Baltimore, Red Rock, Matchless, and Bonny Best. On land containing the wilt disease the wilt-resistant varieties, such as Norton, Norduke, Columbia, Marvena, and Marglobe, are used.

Perennial Crops

General.—This group includes crops which occupy the land more than one season and require special cultural treatment. They are rapidly increasing in importance among our vegetable crops, and in view of the fact that their period of production may continue for many years, as in the case of asparagus, it is important that they be planted only under suitable soil and climatic conditions. They require deep, rich, moist, and well-drained soils, and are rather exacting as to temperature.

Artichoke (Globe).—Grown to some extent in the south Atlantic and Gulf coast region and on a large scale in California. Propagated by suckers taken from older plants. Transplant to rows 3 feet apart and 2 feet apart in the row. Suckers or offshoots planted in the spring produce heads or globes the following spring. The plant makes a vigorous growth. The leaves and stems are of a whitish color and slightly resemble those of a thistle, and the leaves sometimes have prickles or spines. The globes or heads are cut before the flower opens and are shipped to the market in 6-basket carriers, such as are used for peaches and early tomatoes. Globes are prepared for the table by being boiled in water to which a little salt has been added. Serve them whole, and eat them by removing the basal scales, dipping them in drawn butter, and removing the tender, fleshy portion on the inside of the scale by drawing the scales between the front teeth.

Asparagus—*Planting.*—Grown from seed sown in nursery rows at the rate of 1 ounce to 100 feet of row, or about 6 pounds to an acre. Plants are reset to the garden or field when either 1 or 2 years old. Strong 1-year plants having a spread of at least 15 inches of root system are preferable. For commercial growing asparagus plants are set in rows 7 feet apart and the plants 18 to 30 inches apart in the rows. This arrangement requires 2,800 to 3,600 plants per acre. Plants are set in the bottom of a double furrow or trench so that the tops of the crowns are at least 4 inches below the original level of the land. Manure and fertilizer are worked into the bottoms of the trenches before setting. Set the crowns in the early spring, and open the trenches only as necessary, so that the soil will not dry out. Set the plants by hand and spread the roots uniformly in all directions. Cover the crowns with about 2 inches of soil at first, and as the growth proceeds during the summer months work in additional soil around and over them. At the end of the first season or early in the following spring the remaining soil can be worked into the trenches.

Fertilizer.—Apply fertilizer during the first two years in the spring to stimulate growth. A good fertilizer for asparagus consists of 4 or 5 per cent nitrogen, 8 per cent phosphoric acid, and 4 per cent potash, applied at the rate of 1,000 pounds per acre. The entire quantity may be applied at the beginning of the growing season, or about two-thirds may be applied at that time and the remainder put on as side dressings later in the season.

Varieties.—Palmetto, Argenteuil, Conover's Colossal, Reading Giant, and the three strains of Washington rust-resistant, known as Washington, Martha Washington, and Mary Washington, are the leading varieties. The Mary Washington strain is now the most universally planted, especially in the eastern United States.

Cutting.—No shoots should be cut until the third season, and then the cutting period should not exceed four weeks. After the third season the cutting may be extended to 45 to 55 days. An asparagus plantation will continue to produce for 12 to 20 years. After cutting begins the plants should be fertilized just at the close of the cutting period.

Market.—Two forms are grown for the market, the bleached or white "grass," produced by ridging or banking the soil over the crowns and cutting at a considerable depth below the surface, and the other known as green "grass," where the plants are not banked and the shoots are allowed to grow to a height of 8 or 10 inches before being cut. In all cases the shoots should be cut before the head or point begins to "break." The stems or shoots are graded into Fancy No. 1, Standard, and

Culls. The shoots are tied in bunches weighing 2 to 3 pounds each, the butts trimmed even, and the bunches packed 12, 18, or 24 to a crate for shipment.

Horse-Radish.—Thrives best in a deep, rich soil where there is plenty of moisture. Grown from root cuttings saved from the marketable crop the previous season. Cuttings are planted in shallow furrows during early spring, being either dropped in the furrow or set at an angle with top near the surface of the ground. Placed in rows 3 feet apart and 18 inches in the rows. Special culture and fertilizing may produce marketable roots in one year, but the crop frequently is allowed to remain for two seasons. Dig the roots in the late fall and store in pits or cellars. Usually marketed in barrels. The yield is 12 to 30 barrels per acre.

Rhubarb.—Adapted for growing in the cooler parts of the United States, especially where the ground freezes at least 4 inches deep during the winter. For commercial production the plants are set 3 by 4, 4 by 4, or 4 by 5 feet. Propagated by seed and by division of old roots. Propagation by seed requires more time to bring into production than by division of roots. Roots set one spring should not be pulled the next season, but will be in full production for the second season. A rhubarb plantation will last from 5 to 12 years. Varieties are not distinct, but the Linnaeus is most commonly grown. For the market the leaf stems are tied in bunches varying from 4 to 6 stems each, depending upon their size. Stems may be tied in large bundles of 60 to 80, and retied in smaller bunches after reaching the market. Rhubarb frequently is forced in cellars or specially constructed houses, the mature roots being allowed to freeze solid before removal to the forcing cellar or house. Is forced in almost total darkness, in order to produce a tender stem with a very small leaf.

Sea Kale.—Propagated by either root cuttings or seeds, but grows more quickly from cuttings. Plant like rhubarb, setting 3 or 4 feet apart each way. Requires rich, moist soil, and when planted by means of root cuttings it may be cut the second spring. When planted by seeds it will not be ready before the third year. Sea kale has large cabbagelike leaves and is rather ornamental. Blanch the young shoots in the early spring by banking loose earth over them or by covering the plant with an inverted box to exclude the light. Shoots are eaten like asparagus, before the leaves begin to expand and while young and tender. For marketing the shoots are tied in bunches the same as asparagus and shipped in crates or boxes, each bundle of shoots being wrapped in attractive white paper and the ends of the bundle being left open.

Miscellaneous.—A number of perennial plants are grown as herbs in conjunction with the vegetable garden, and are used mainly for seasoning and for salads. Among the most commonly grown are angelica, balm, fennel, lavender, lovage, marjoram, mint, peppermint, rosemary, rue, sage tansy, tarragon, and thyme.

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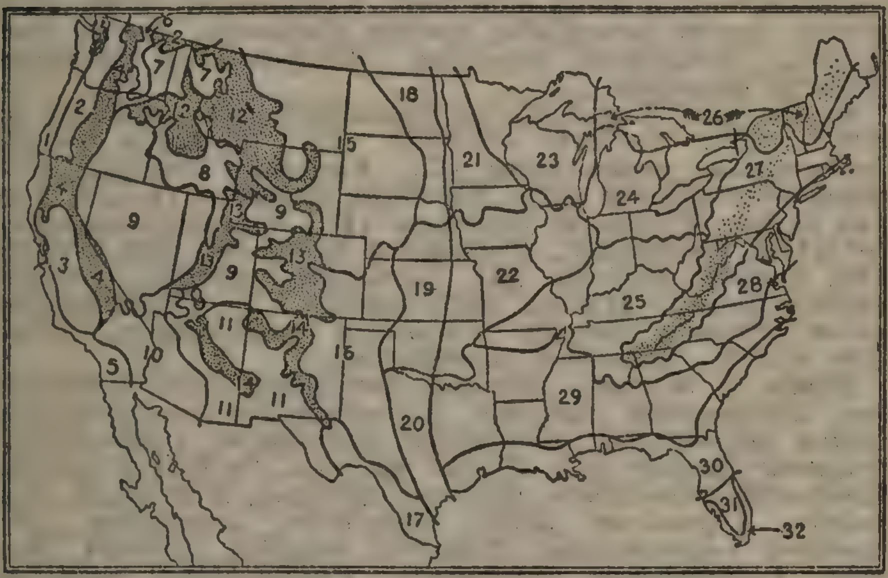
ORNAMENTALS

General

For permanent effects in ornamental planting about farm homes and in other places woody plants, both deciduous and evergreen, should be used. Their effect is continuous from year to year, and winter as well as summer decoration can be provided. Plants native to any section should be given first consideration. These may be observed in the woods and fields in summer and transplanted at the next appropriate transplanting season. Next in value are those suggested in the following lists. Many of these plants are also native.

Ornamental plants for use in the different regions shown on the regional map are arranged in the follow-



Map designating climatic regions to be followed in the planting of ornamentals

ing list according to their approximate ultimate heights. This height will vary much, according to the region where grown, to the character, tilth, fertility, moisture content, and acidity of the soil, the exposure, and the care the plants receive. Local nursery catalogues will give more detailed information about the plants.

Those plants not specially designated in the lists are deciduous; that is, they drop their leaves on the advent of frosty weather. The others are followed by special marks, such as B, broad-leaf evergreens; C, cone-bearing evergreens; H, half evergreens; that is, hold their leaves until midwinter or after; and P, palms or palmlike.

Plants for Region 1

Shrubs to 2 Feet or Under.—*Andromeda polifolia* (B), *Berberis repens* (B), *Calluna vulgaris* (B), *Ceanothus americanus*, *Chamædaphne calyculata* (B), *Cotoneaster buxifolia*, *Cotoneaster microphylla* (B), *Daphne cneorum*

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(B), *Erica carnea* (B), *Erica vagans* (B), *Hypericum moserianum* (B), *Juniperus communis depressa* (C), *Juniperus prostrata* (C), *Rhus aromatica.*

Shrubs to 4 Feet.—*Azalea amœna* (B), *Callicarpa purpurea, cotoneaster simonsi, Daphne mezereum, Deutzia gracilis, Evonymus radicans, Kalmia angustifolia* (B), *Pieris floribunda* (B), *Robinia hispida, Rosa bracteata, Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa, Symphoricarpos occidentalis, Symphoricarpos racemosus, Symphoricarpos vulgaris, Viburnum acerifolium.*

Shrubs to 6 Feet.—*Azalea indica* (B), *Azalea nudiflora, Berberis aquifolium* (B), *Berberis thunbergi, Buxus sempervirens suffruticosa* (B), *Callicarpa americana, Calycanthus floridus, Caryopteris mastacanthus, Cephalanthus occidentalis, Clethra alnifolia, Cornus alba, Cornus sanguinea, Cornus stolonifera flaviramea, Cydonia japonica, Deutzia crenata, Diervilla rosea, Hydrangea arborescens, Hydrangea arborescens sterilis, Hydrangea quercifolia, Jasminum nudiflorum, Juniperus sabina* (C), *Juniperus squamata* (C), *Kerria japonica, Ligustrum ibota regelianum, Lonicera morrowi, Nandina japonica* (B), *Rhodotypos kerrioides, Ribes odoratum, Ribes americanum, Rosa rugosa, Spiræa prunifolia, Spiræa thunbergi, Spiræa vanhouttei, Staphylea bumalda, Stephanandra flexuosa, Tamarix odessana.*

Shrubs to 8 Feet.—*Abelia grandiflora* (H), *Aucuba japonica* (B), *Berberis ilicifolia* (H), *Buddleia davidi, Cephalotaxus pedunculata* (C), *Elæagnus longipes, Elæagnus macrophylla* (B), *Elæagnus pungens* (B), *Evonymus alatus, Evonymus japonicus* (B), *Forsythia suspensa, Forsythia viridissima, Hydrangea hortensis, Ilex verticillata, Kalmia latifolia* (B), *Ligustrum sinense, Lonicera fragrantissima, Myrica carolinensis* (H), *Philadelphus lewisi, Prunus pumila, Viburnum americanum, Viburnum nudum, Viburnum tomentosum.*

Shrubs to 10 Feet.—*Æsculus parviflora, Alnus mitchelliana, Amelanchier alnifolia, Acanthopanax pentaphyllum, Azalea calendulacea, Ceanothus thyrsiflorus, Cephalotaxus drupacea sinensis* (C), *Cercis japonica, Cytisus scoparius, Exochorda grandiflora, Hibiscus syriacus, Hydrangea paniculata, Ligustrum ibota, Ligustrum japonicum* (B), *Lonicera ruprechtiana, Lonicera tatarica, Lycium chinense, Philadelphus coronarius, Philadelphus inodorus, Physocarpus opulifolius, Rhododendron catawbiense* (B), *Spartium junceum, Staphylea trifolia, Syringa chinensis, Syringa persica, Tamarix gallica, Thuja occidentalis* (*dwarf varieties*) (C), *Thuja orientalis* (*dwarf varieties*) (C), *Viburnum opulus.*

Shrubs to 15 Feet.—*Amorpha fruticosa, Chamæcyparis obtusa* (C), *Chamæcyparis pisifera* (C), *Chamæcyparis pisifera filifera* (C), *Chamæcyparis pisifera plumosa* (C), *Chamæcyparis pisifera squarrosa* (C), *Chionanthus virginica, Colutea arborescens, Cornus florida, Cornus mas, Cornus paniculata, Cratægus oxyacantha, Hamamelis virginiana, Hydrangea paniculata grandiflora, Ilex vomitoria* (B), *Juniperus scopulorum* (C), *Ligustrum amurense, Magnolia stellata, Osmanthus aquifolium* (B), *Osmanthus fragrans* (B), *Photinia serrulata* (B), *Prunus pissardi, Punica granatum* (B), *Pyracantha coccinea lalandi* (H), *Rhododendron maximum* (B), *Rhus cotinus, Rhus glabra, Salix caprea, Sambucus canadensis, Sambucus pubens, Syringa vulgaris, Viburnum prunifolium.*

Shrubs or Small Trees to 20 Feet.—*Amelanchier oblongifolia, Camellia japonica* (B), *Caragana arborescens, Coprosma baueri* (tall form) (B), *Elæagnus angustifolia, Evonymus atropurpureus, Ilex crenata* (B), *Ligustrum*

lucidum (B), *Melaleuca decussata, Pieris japonica* (B), *Ptelea trifoliata* (B).

Shrubs or Small Trees to 25 Feet.—*Amelanchier canadensis, Buxus sempervirens* (B), *Cercis canadensis, Cratægus crusgalli, Ilex aquifolium* (B), *Juniperus chinensis* (C), *Juniperus communis* (C), *Juniperus excelsa* (C), *Juniperus virginiana* (C), *Lagerstrœmia indica, Ligustrum ovalifolium* (H), *Prunus caroliniana* (B), *Styrax japonica, Syringa japonica.*

Large Trees.—London plane, English elm, Oregon maple, madrone (B), European linden, California black walnut, American elm, Huntingdon elm, California sycamore, honey locust, black locust.

Plants for Region 2

Shrubs to 2 Feet or Under.—*Berberis repens* (B), *Calluna vulgaris* (B), *Ceanothus americanus, Cotoneaster buxifolia, Cotoneaster microphylla* (B), *Daphne cneorum* (B), *Erica carnea* (B), *Hypericum moserianum, Juniperus communis depressa* (C), *Juniperus prostrata* (C), *Rhus aromatica.*

Shrubs to 4 Feet.—*Callicarpa purpurea, Cotoneaster simonsi, Daphne mezereum, Deutzia gracilis, Evonymus radicans, Pieris floribunda* (B), *Rosa bracteata, Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa, Symphoricarpos occidentalis, Symphoricarpos racemosus, Symphoricarpos vulgaris, Viburnum acerifolium.*

Shrubs to 6 Feet.—*Azalea nudiflora, Berberis aquifolium* (B), *Berberis thunbergi, Buddleia davidi, Callicarpa americana, Calycanthus floridus, Caryopteris mastacanthus, Cephalanthus occidentalis, Clethra alnifolia, Cornus alba, Cornus sanguinea, Cornus stolonifera flaviramea, Cydonia japonica, Deutzia crenata, Diervilla rosea, Hydrangea arborescens, Hydrangea arborescens sterilis, Jasminum nudiflorum, Juniperus sabina* (C), *Kerria japonica, Ligustrum regelianum, Lonicera morrowi, Nandina japonica* (B), *Rhodotypos kerrioides, Ribes odoratum, Rosa rugosa, Spiræa prunifolia, Spiræa thunbergi, Spiræa vanhouttei, Staphylea bumalda, Stephanandra flexuosa, Tamarix odessana, Viburnum suspensum* (B).

Shrubs to 8 Feet.—*Abelia grandiflora* (H), *Aucuba japonica* (B), *Berberis ilicifolia* (B), *Cephalotaxus pedunculata* (C), *Elæagnus longipes, Evonymus alatus, Evonymus japonicus* (B), *Forsythia suspensa, Forsythia viridissima, Ilex verticillata, Kalmia latifolia* (B), *Ligustrum sinense, Lonicera fragrantissima, Philadelphus lewisi, Prunus pumila, Viburnum americanum, Viburnum dentatum, Viburnum nudum, Viburnum tinus* (B), *Viburnum tomentosum.*

Shrubs to 10 Feet.—*Æsculus parviflora, Alnus mitchelliana, Amelanchier alnifolia, Acanthopanax pentaphyllum, Ceanothus thyrsiflorus, Cephalotaxus drupacea sinensis* (C), *Cercis japonica, Cytisus scoparius, Exochorda grandiflora, Hibiscus syriacus, Hydrangea paniculata, Ligustrum ibota, Ligustrum japonicum* (B), *Lonicera ruprechtiana, Lonicera tatarica, Lycium chinense, Philadelphus coronarius, Philadelphus inodorus, Physocarpus opulifolius, Spartium junceum, Syringa chinensis, Syringa persica, Tamarix gallica, Thuja occidentalis* (dwarf varieties) (C), *Thuja orientalis* (dwarf varieties) (C), *Viburnum opulus.*

Shrubs to 15 Feet.—*Colutea arborescens, Cornus florida, Cornus mas, Cornus paniculata, Cratægus oxyacantha, Hamamelis virginiana, Hydrangea paniculata grandiflora, Ilex vomitoria* (B), *Juniperus scopulorum* (C), *Ligustrum amurense, Osmanthus aquifolium* (B), *Osmanthus fragrans*

(B), *Photinia serrulata* (B), *Prunus pissardi, Punica granatum* (B), *Pyracantha coccinea lalandi* (H), *Rhododendron maximum* (B), *Rhus cotinus, Salix caprea, Sambucus canadensis, Sambucus pubens, Staphylea trifolia, Syringa vulgaris, Viburnum prunifolium.*

Shrubs or Small Trees to 20 Feet.—*Amelanchier oblongifolia, Caragana arborescens, Coprosma baueri* (tall form), *Elæagnus angustifolia, Evonymus atropurpureus, Ilex crenata* (B), *Melaleuca decussata, Ptelea trifoliata.*

Shrubs or Small Trees to 25 Feet.—*Amelanchier canadensis, Cercis canadensis, Cratægus crusgalli, Ilex aquifolium* (B), *Juniperus chinensis* (C), *Juniperus communis* (C), *Juniperus excelsa* (C), *Juniperus virginiana* (C), *Lagerstrœmia indica, Ligustrum ovalifolium, Styrax japonica, Syringa japonica.*

Large Trees.—Oregon, maple, madrone (B), honey locust, white oak, sugar maple, California black walnut, black locust.

Plants for Region 3

Shrubs to 2 Feet or Under.—*Berberis repens* (B), *Cotoneaster buxifolia, Cotoneaster microphylla* (B), *Daphne cneorum* (B), *Hypericum moserianum, Juniperus communis depressa* (C), *Juniperus prostrata* (C).

Shrubs to 4 Feet.—*Cotoneaster simonsi, Daphne mezereum, Evonymus radicans* (B), *Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa.*

Shrubs to 6 Feet.—*Berberis aquifolium* (B), *Berberis thunbergi, Callicarpa americana, Caryopteris mastacanthus, Cornus sanguinea, Cydonia japonica, Diervilla rosea, Hydrangea arborescens, Hydrangea arborescens sterilis, Jasminum nudiflorum, Juniperus sabina* (C), *Kerria japonica, Ligustrum ibota regelianum, Lonicera morrowi, Nandina japonica* (B), *Rhodotypos kerrioides, Rosa rugosa, Spiræa prunifolia, Spiræa thunbergi, Spiræa vanhouttei, Tamarix odessana.*

Shrubs to 8 Feet.—*Abelia grandiflora* (H), *Aucuba japonica* (B), *Berberis ilicifolia* (B), *Cephalotaxus pedunculata* (C), *Datura arborea* (H), *Elæagnus longipes, Elæagnus macrophylla* (B), *Elæagnus pungens* (B), *Escallonia montevidensis* (B), *Evonymus alatus, Evonymus japonicus* (B), *Forsythia suspensa, Forsythia viridissima, Ilex verticillata, Ligustrum sinense, Lonicera fragrantissima, Philadelphus lewisi.*

Shrubs to 10 Feet.—*Acanthopanax pentaphyllum, Callistemon lanceolatus, Ceanothus thyrsiflorus, Cytisus scoparius, Hibiscus syriacus, Hydrangea paniculata, Ligustrum ibota, Ligustrum japonicum* (B), *Lonicera ruprechtiana, Lonicera tatarica, Lycium chinense, Myrtus communis* (B), *Philadelphus coronarius, Philadelphus inodorus, Physocarpus opulifolius, Pittosporum tobira* (B), *Spartium junceum, Syringa chinensis, Syringa persica, Tamarix gallica, Thuja occidentalis* (dwarf varieties) (C).

Shrubs to 15 Feet.—*Colutea arborescens, Cornus florida, Cornus mas, Cratægus oxyacantha, Heteromeles arbutifolia* (B), *Hydrangea paniculata grandiflora, Ilex vomitoria* (B), *Juniperus scopulorum* (C), *Ligustrum amurense, Nerium oleander* (B), *Osmanthus aquifolium* (B), *Osmanthus fragrans* (B), *Prunus pissardi, Punica granatum* (B), *Pyracantha coccinea lalandi* (H), *Salix caprea, Sambucus canadensis, Sambucus pubens, Syringa vulgaris.*

Shrubs or Small Trees to 20 Feet.—*Camellia japonica, Caragana arborescens, Coprosma baueri* (tall form) (B), *Elæagnus angustifolia, Evonymus atropurpureus, Juniperus virginiana* (C), *Ligustrum lucidum* (B), *Melaleuca decussata, Pittosporum phillyræoides* (B).

Shrubs or Small Trees to 25 Feet.—*Juniperus communis* (C), *Juniperus excelsa* (C), *Lagerstrœmia indica*, *Ligustrum ovalifolium* (H), *Pittosporum undulatum* (B), *Prunus ilicifolia* (B), *Prunus caroliniana* (B), *Syringa japonica*.

Large Trees.—London plane, California black walnut, American elm, English elm, valley oak (B), Arizona ash, California sycamore, Oregon ash, Koelreuteria, and, in the warmer parts, Washington palms (P).

Plants for Region 4

Shrubs to 2 Feet or Under.—*Berberis repens* (B), *Calluna vulgaris* (B), *Ceanothus americanus*, *Chamædaphne calyculata* (B), *Cotoneaster buxifolia*, *Cotoneaster microphylla* (B), *Juniperus prostrata* (C), *Juniperus communis depressa* (C).

Shrubs to 4 Feet.—*Azalea amœna* (B), *Cotoneaster simonsi*, *Spiræa bumalda*, *Spiræa bumalda* Anthony Waterer, *Spiræa japonica*, *Spiræa tomentosa*, *Symphoricarpos occidentalis*, *Symphoricarpos racemosus*, *Symphoricarpos vulgaris*.

Shrubs to 6 Feet.—*Azalea nudiflora* (B), *Berberis aquifolium* (B), *Berberis thunbergi*, *Calycanthus floridus*, *Caryopteris mastacanthus*, *Cephalanthus occidentalis*, *Clethra alnifolia*, *Cornus sanguinea*, *Cornus stolonifera flaviramea*, *Cydonia japonica*, *Juniperus sabina* (C), *Ligustrum ibota regelianum*, *Lonicera morrowi*, *Rhodotypos kerrioides*, *Ribes odoratum*, *Rosa rugosa*, *Spiræa prunifolia*, *Spiræa thunbergi*, *Spiræa vanhouttei*, *Staphylea bumalda*.

Shrubs to 8 Feet.—*Abelia grandiflora* (H), *Elæagnus longipes*, *Evonymus alatus*, *Ilex verticillata*, *Lonicera fragrantissima*, *Philadelphus lewisi*, *Prunus pumila*, *Viburnum americanum*.

Shrubs to 10 Feet.—*Æsculus parviflora*, *Alnus mitchelliana*, *Amelanchier alnifolia*, *Azalea calendulacea*, *Ceanothus thyrsiflorus*, *Cytisus scoparius*, *Hydrangea paniculata*, *Ligustrum ibota*, *Lonicera ruprechtiana*, *Lonicera tatarica*, *Lycium chinense*, *Philadelphus coronarius*, *Philadelphus inodorus*, *Physocarpus opulifolius*, *Staphylea trifolia*, *Syringa chinensis*, *Thuja occidentalis* (dwarf varieties) (C).

Shrubs to 15 Feet.—*Chionanthus virginica*, *Colutea arborescens*, *Cornus florida*, *Cornus paniculata*, *Cratægus oxyacantha*, *Hamamelis virginiana*, *Hydrangea paniculata grandiflora*, *Juniperus scopulorum* (C), *Ligustrum amurense*, *Prunus pissardi*, *Pyracantha coccinea lalandi* (H), *Salix caprea*, *Sambucus canadensis*, *Sambucus pubens*, *Syringa vulgaris*.

Shrubs or Small Trees to 20 Feet.—*Amelanchier oblongifolia*, *Caragana arborescens*, *Elæagnus angustifolia*, *Evonymus atropurpureus*, *Ptelea trifoliata*.

Shrubs or Small Trees to 25 Feet.—*Amelanchier canadensis*, *Cercis canadensis*, *Juniperus virginiana* (C).

Large Trees.—London plane, black locust, English elm, Oregon maple, American elm, mossycup oak.

Plants for Region 5

Shrubs to 2 Feet or Under.—*Daphne cneorum* (B).

Shrubs to 4 Feet.—*Cistus ladaniferus* (B), *Daphne mezereum*, *Spiræa bumalda*, *Spiræa bumalda* Anthony Waterer, *Spiræa japonica*.

Shrubs to 6 Feet.—*Berberis thunbergi*, *Caryopteris mastacanthus*, *Cornus sanguinea*, *Diervilla rosea*, *Jasminum nudiflorum*, *Ligustrum ibota regelianum*, *Lonicera*

morrowi, Nandina japonica (B), *Spiræa prunifolia, Tamarix odessana, Viburnum suspensum.*

Shrubs to 8 Feet.—*Abelia grandiflora* (H), *Aucuba japonica* (B), *Berberis ilicifolia* (B), *Datura arborea* (H), *Elæagnus longipes, Elæagnus macrophylla* (B), *Elæagnus pungens* (B), *Escallonia montevidensis* (B), *Evonymus japonicus* (B), *Forsythia suspensa, Forsythia viridissima, Ligustrum sinense, Lonicera fragrantissima, Philadelphus lewisi, Viburnum tinus* (B).

Shrubs to 10 Feet.—*Acanthopanax pentaphyllum, Callistemon lanceolatus, Ceanothus thyrsiflorus, Cytisus scoparius, Hibiscus syriacus, Hydrangea paniculata, Ligustrum ibota, Ligustrum japonicum* (B), *Lonicera ruprechtiana, Lonicera tatarica, Lycium chinense, Pittosporum tobira* (B), *Spartium junceum, Syringa chinensis, Syringa persica, Tamarix gallica.*

Shrubs to 15 Feet.—*Colutea arborescens, Cratægus oxyacantha, Heteromeles arbutifolia* (B), *Hydrangea paniculata grandiflora, Ligustrum amurense, Nerium oleander* (B), *Photinia serrulata* (B), *Punica granatum* (B), *Pyracantha coccinea lalandi* (H), *Sambucus canadensis, Sambucus pubens, Syringa vulgaris.*

Shrubs or Small Trees to 20 Feet.—*Camellia japonica* (B), *Caragana arborescens, Coprosma baueri* (tall varieties) (B), *Elæagnus angustifolia, Jasminum humile* (B), *Ligustrum lucidum* (B), *Melaleuca decussata, Pittosporum phillyrœoides* (B), *Thea sinensis* (B).

Shrubs or Small Trees to 25 Feet.—*Lagerstrœmia indica, Ligustrum ovalifolium* (H), *Pittosporum undulatum* (B), *Prunus ilicifolia* (B), *Prunus caroliniana* (B), *Syringa japonica.*

Large Trees.—Valley oak (B), California pepper tree, rubber tree (B), Arizona cypress (C), Guadalupe cypress (C), Monterey cypress (C), red gum (*Eucalyptus longirostris*) (B), manna gum (*Eucalyptus viminalis*) (B), and many palms.

Plants for Region 6

Shrubs to 2 Feet or Under.—*Berberis repens* (B), *Calluna vulgaris* (B), *Ceanothus americanus, Cotoneaster microphylla* (B), *Juniperus communis depressa* (C), *Juniperus prostrata* (C), *Rhus aromatica.*

Shrubs to 4 Feet.—*Daphne mezereum, Deutzia gracilis, Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa, Symphoricarpos occidentalis, Symphoricarpos racemosus, Symphoricarpos vulgaris, Viburnum acerifolium.*

Shrubs to 6 Feet.—*Azalea nudiflora* (B), *Berberis aquifolium* (B), *Calycanthus floridus, Caryopteris mastacanthus, Cephalanthus occidentalis, Clethra alnifolia, Cornus sanguinea, Cornus stolonifera flaviramea, Cydonia japonica, Diervilla rosea, Juniperus sabina* (C), *Ligustrum ibota regelianum, Lonicera morrowi, Rhodotypos kerrioides, Ribes odoratum, Ribes americanum, Rosa carolina, Rosa rugosa, Rosa setigera, Spiræa prunifolia, Spiræa thunbergi, Spiræa vanhouttei, Staphylea bumalda, Stephanandra flexuosa, Tamarix odessana.*

Shrubs to 8 Feet.—*Evonymus alatus, Forsythia suspensa, Ilex verticillata, Lonicera fragrantissima, Philadelphus lewisi, Viburnum americanum.*

Shrubs to 10 Feet.—*Alnus mitchelliana, Amelanchier alnifolia, Cytisus scoparius, Exochorda grandiflora, Hibiscus syriacus, Hydrangea paniculata, Ligustrum ibota, Lonicera ruprechtiana, Lonicera tatarica, Philadelphus coronarius, Philadelphus inodorus, Physocarpus opulifolius, Staphylea trifolia, Syringa chinensis, Tamarix gallica, Thuja occidentalis* (dwarf varieties) (C), *Viburnum opulus.*

Shrubs to 15 Feet.—*Colutea arborescens, Cornus florida, Cornus paniculata, Cratægus oxyacantha, Hamamelis virginiana, Hydrangea paniculata grandiflora, Juniperus scopulorum* (C), *Ligustrum amurense, Pyracantha coccinea lalandi* (H), *Salix caprea, Sambucus canadensis, Sambucus pubens, Syringa vulgaris.*

Shrubs or Small Trees to 20 Feet.—*Amelanchier oblongifolia, Caragana arborescens, Elæagnus angustifolia, Evonymus atropurpureus, Ptelea trifoliata.*

Shrubs or Small Trees to 25 Feet.—*Amelanchier canadensis, Cercis canadensis, Cratægus crusgalli, Juniperus communis* (C), *Juniperus virginiana* (C), *Styrax japonica, Syringa japonica.*

Large Trees.—London plane, English elm, European linden, green ash, black locust, European ash, white ash, Norway maple, red oak.

Plants for Region 7

Shrubs to 2 Feet or Under.—*Berberis repens* (B), *Calluna vulgaris* (B), *Ceanothus americanus, Juniperus communis depressa* (C), *Juniperus prostrata* (C), *Rhus aromatica.*

Shrubs to 4 Feet.—*Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa, Symphoricarpos occidentalis, Symphoricarpos racemosus, Symphoricarpos vulgaris, Viburnum acerifolium.*

Shrubs to 6 Feet.—*Azalea nudiflora, Berberis aquifolium* (B), *Cephalanthus occidentalis, Clethra alnifolia, Cornus sanguinea, Cornus stolonifera flaviramea, Cydonia japonica, Juniperus sabina* (C), *Ligustrum ibota regelianum, Lonicera morrowi, Rhodotypos kerrioides, Ribes americanum, Ribes odoratum, Rosa carolina, Rosa rugosa, Spiræa prunifolia, Spiræa thunbergi, Spiræa vanhouttei, Staphylea bumalda, Tamarix odessana.*

Shrubs to 8 Feet.—*Ilex verticillata, Philadelphus lewisi, Viburnum americanum.*

Shrubs to 10 Feet.—*Alnus mitchelliana, Amelanchier alnifolia, Cytisus scoparius, Hydrangea paniculata, Ligustrum ibota, Lonicera ruprechtiana, Lonicera tatarica, Philadelphus coronarius, Philadelphus inodorus, Physocarpus opulifolius, Staphylea trifolia, Syringa chinensis, Tamarix gallica, Viburnum opulus.*

Shrubs to 15 Feet.—*Cornus florida, Cornus paniculata, Cratægus oxyacantha, Hamamelis virginiana, Hydrangea paniculata grandiflora, Juniperus scopulorum* (C), *Ligustrum amurense, Salix caprea, Sambucus canadensis, Sambucus pubens, Syringa vulgaris.*

Shrubs or Small Trees to 20 Feet.—*Amelanchier oblongifolia, Caragana arborescens, Elæagnus angustifolia, Evonymus atropurpureus, Ptelea trifoliata.*

Shrubs or Small Trees to 25 Feet.—*Amelanchier canadensis, Cercis canadensis, Cratægus crusgalli, Juniperus communis* (C), *Juniperus virginiana* (C).

Large Trees.—Green ash, thornless honey locust, black locust, American elm, Norway maple, sycamore maple, cottonwood, Carolina poplar, silver poplar.

Plants for Region 8

Shrubs to 2 Feet or Under.—*Berberis repens* (B), *Ceanothus americanus, Juniperus communis depressa* (C), *Juniperus prostrata* (C).

Shrubs to 4 Feet.—*Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa, Symphoricarpos occidentalis, Symphoricarpos racemosus, Symphoricarpos vulgaris.*

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Shrubs to 6 Feet.—*Azalea nudiflora, Berberis aquifolium* (B), *Cornus sanguinea, Cornus stolonifera flaviramea, Cydonia japonica, Juniperus sabina* (C), *Ligustrum ibota regelianum, Rhodotypos kerrioides, Ribes odoratum, Spiræa prunifolia, Spiræa thunbergi, Spiræa vanhouttei, Staphylea bumalda, Tamarix odessana.*

Shrubs to 8 Feet.—*Elæagnus longipes, Ilex verticillata, Philadelphus lewisi, Staphylea trifolia.*

Shrubs to 10 Feet.—*Amelanchier alnifolia, Cytisus scoparius, Hydrangea paniculata, Ligustrum ibota, Lonicera ruprechtiana, Lonicera tatarica, Philadelphus coronarius, Philadelphus inodorous, Physocarpus opulifolius, Syringa chinensis, Tamarix gallica.*

Shrubs to 15 Feet.—*Cornus florida, Cornus paniculata, Cratægus oxyacantha, Hamamelis virginiana, Hydrangea paniculata grandiflora, Juniperus scopulorum* (C), *Ligustrum amurense, Sambucus canadensis, Sambucus pubens, Syringa vulgaris.*

Shrubs or Small Trees to 20 Feet.—*Amelanchier oblongifolia, Caragana arborescens, Elæagnus angustifolia, Evonymus atropurpureus, Ptelea trifoliata.*

Shrubs or Small Trees to 25 Feet.—*Amelanchier canadensis, Cratægus crusgalli, Juniperus communis* (C), *Juniperus virginiana* (C).

Large Trees.—Green ash, honey locust, black locust.

Plants for Region 9

Shrubs to 2 Feet or Under.—*Berberis repens* (B).

Shrubs to 4 Feet.—*Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa, Symphoricarpos occidentalis.*

Shrubs to 6 Feet.—*Berberis aquifolium* (B), *Cephalanthus occidentalis, Cornus sanguinea, Cornus stolonifera flaviramea, Cydonia japonica, Ligustrum ibota regelianum, Spiræa prunifolia, Spiræa thunbergi, Spiræa vanhouttei, Tamarix odessana.*

Shrubs to 8 Feet.—*Elæagnus longipes, Ligustrum ibota, Philadelphus lewisi.*

Shrubs to 10 Feet.—*Amelanchier alnifolia, Cytisus scoparius, Philadelphus coronarius, Philadelphus inodorus, Physocarpus opulifolius, Syringa chinensis, Tamarix gallica.*

Shrubs to 15 Feet.—*Cornus florida, Cratægus oxyacantha, Ligustrum amurense, Sambucus pubens, Syringa vulgaris.*

Shrubs or Small Trees to 20 Feet.—*Amelanchier oblongifolia, Caragana arborescens, Elæagnus angustifolia, Evonymus atropurpureus.*

Large Trees.—Green ash, thornless honey locust, black locust, Chinese elm, mossycup oak, white oak, cottonwood.

Plants for Region 10

Shrubs to 4 Feet.—*Spiræa bumalda* Anthony Waterer, *Spiræa japonica.*

Shrubs to 6 Feet.—*Caryopteris mastacanthus, Tamarix odessana.*

Shrubs to 8 Feet.—*Datura arborea* (H), *Elæagnus longipes, Ligustrum sinense.*

Shrubs to 10 Feet.—*Callistemon lanceolatus, Ceanothus thyrsiflorus, Cytisus scoparius, Hibiscus syriacus, Pittosporum tobira* (B), *Spartium junceum, Tamarix gallica.*

Shrubs or Small Trees to 20 Feet.—*Elæagnus angustifolia, Melaleuca decussata, Pittosporum phillyræoides* (B).

Shrubs or Small Trees to 25 Feet.—*Ligustrum ovalifolium* (H), *Pittosporum undulatum* (B).

Large Trees.—Athel (*Tamarix articulata*), desert gum (*Eucalyptus rudis*) (B), red gum (*Eucalyptus longirostris*) (B), red box (*Eucalyptus polyanthemos*) (B), Parkinsonia, Texas palmetto (P), Washington palms (P).

Plants for Region 11

Shrubs to 2 Feet or Under.—*Berberis repens.*

Shrubs to 4 Feet.—*Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa.*

Shrubs to 6 Feet.—*Berberis aquifolium, Caryopteris mastacanthus, Cephalanthus occidentalis, Cornus sanguinea, Spiræa prunifolia, Spiræa thunbergi, Spiræa vanhouttei, Tamarix odessana.*

Shrubs to 8 Feet.—*Datura arborea* (H), *Ligustrum sinense.*

Shrubs to 10 Feet.—*Ceanothus thyrsiflorus, Cytisus scoparius, Hibiscus syriacus, Lonicera ruprechtiana, Lonicera tatarica, Philadelphus coronarius, Physocarpus opulifolius, Syringa chinensis, Tamarix gallica.*

Shrubs to 15 Feet.—*Cornus florida, Sambucus pubens.*

Shrubs or Small Trees to 20 Feet.—*Caragana arborescens, Elæagnus angustifolia, Melaleuca decussata.*

Shrubs or Small Trees to 25 Feet.—*Ligustrum ovalifolium.*

Large Trees.—Thornless honey locust, green ash, black locust, hackberry, Mississippi hackberry, Chinese elm, cottonwood, Parkinsonia, Texas palmetto (P).

Plants for Region 12

Shrubs to 2 Feet or Under.—*Berberis repens, Ceanothus americanus, Juniperus communis depressa* (C), *Juniperus prostrata* (C), *Rhus aromatica.*

Shrubs to 4 Feet.—*Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa, Symphoricarpos occidentalis, Symphoricarpos racemosus, Symphoricarpos vulgaris.*

Shrubs to 6 Feet.—*Azalea nudiflora, Clethra alnifolia, Cornus alba, Cornus sanguinea, Cornus stolonifera flaviramea, Juniperus sabina* (C), *Ligustrum ibota regelianum, Ribes odoratum, Spiræa prunifolia, Staphylea bumalda.*

Shrubs to 8 Feet.—*Ilex verticillata, Philadelphus lewisi, Viburnum americanum.*

Shrubs to 10 Feet.—*Alnus mitchelliana, Amelanchier alnifolia, Ligustrum ibota, Philadelphus coronarius, Philadelphus inodorus, Physocarpus opulifolius, Pinus montana mughus* (C), *Staphylea trifolia, Syringa chinensis.*

Shrubs to 15 Feet.—*Cornus florida, Hamamelis virginiana, Juniperus scopulorum* (C), *Ligustrum amurense, Sambucus canadensis, Sambucus pubens, Syringa vulgaris.*

Shrubs or Small Trees to 20 Feet.—*Amelanchier oblongifolia, Caragana arborescens, Elæagnus angustifolia, Ptelea trifoliata.*

Shrubs or Small Trees to 25 Feet.—*Amelanchier canadensis, Juniperus chinensis* (C), *Juniperus communis* (C), *Juniperus virginiana* (C).

Large Trees.—Green ash, hackberry, cottonwood, silver poplar, narrow-leaf cottonwood.

Plants for Region 13

Shrubs to 2 Feet or Under.—*Berberis repens* (B), *Ceanothus americanus, Juniperus communis depressa* (C), *Juniperus prostrata* (C), *Rhus aromatica.*

Shrubs to 4 Feet.—*Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa,*

Symphoricarpos occidentalis, Symphoricarpos racemosus, Symphoricarpos vulgaris.

Shrubs to 6 Feet.—*Azalea nudiflora, Berberis aquifolium* (B), *Calycanthus floridus, Cephalanthus occidentalis, Clethra alnifolia, Cornus alba, Cornus sanguinea, Cornus stolonifera flaviramea, Juniperus sabina* (C), *Ligustrum ibota regelianum, Ribes americanum, Ribes odoratum, Spiræa prunifolia, Staphylea bumalda.*

Shrubs to 8 Feet.—*Elæagnus longipes, Ilex verticillata, Philadelphus lewisi, Viburnum americanum.*

Shrubs to 10 Feet.—*Alnus mitchelliana, Amelanchier alnifolia, Ligustrum ibota, Philadelphus coronarius, Philadelphus inodorus, Physocarpus opulifolius, Pinus montana mughus* (C), *Staphylea trifolia, Syringa chinensis.*

Shrubs to 15 Feet.—*Cornus florida, Hamamelis virginiana, Juniperus scopulorum* (C), *Ligustrum amurense, Sambucus canadensis, Sambucus pubens, Syringa vulgaris,*

Shrubs or Small Trees to 20 Feet.—*Amelanchier oblongifolia, Caragana arborescens, Elæagnus angustifolia, Evonymus atropurpureus, Ptelea trifoliata.*

Shrubs or Small Trees to 25 Feet.—*Amelanchier canadensis, Juniperus chinensis* (C), *Juniperus communis* (C), *Juniperus virginiana* (C).

Large Trees.—Green ash, Koelreuteria, cottonwood and other poplars, black locust, hackberry, thornless honey locust, ash-leaf maple (as a last resort).

Plants for Region 14

Shrubs to 2 Feet or Under.—*Berberis repens, Ceanothus americanus, Juniperus communis depressa* (C), *Juniperus prostrata* (C), *Rhus aromatica.*

Shrubs to 4 Feet.—*Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa, Symphoricarpos occidentalis, Symphoricarpos racemosus, Symphoricarpos vulgaris.*

Shrubs to 6 Feet.—*Azalea nudiflora, Berberis aquifolium, Calycanthus floridus, Cephalanthus occidentalis, Clethra alnifolia, Cornus alba, Cornus sanguinea, Cornus stolonifera flaviramea, Juniperus sabina* (C), *Ligustrum ibota regelianum, Ribes americanum, Ribes odoratum, Spiræa prunifolia, Spiræa thunbergi, Spiræa vanhouttei, Staphylea bumalda.*

Shrubs to 8 Feet.—*Elæagnus longipes, Ilex verticillata, Philadelphus lewisi, Viburnum americanum.*

Shrubs to 10 Feet.—*Alnus mitchelliana, Amelanchier alnifolia, Ligustrum ibota, Philadelphus coronarius, Philadelphus inodorus, Physocarpus opulifolius, Pinus montana mughus* (C), *Staphylea trifolia, Viburnum opulus.*

Shrubs to 15 Feet.—*Cornus florida, Hamamelis virginiana, Juniperus scopulorum* (C), *Ligustrum amurense, Sambucus canadensis, Sambucus pubens, Syringa vulgaris.*

Shrubs or Small Trees to 20 Feet.—*Amelanchier oblongifolia, Caragana arborescens, Elæagnus angustifolia, Evonymus atropurpureus, Ptelea trifoliata.*

Shrubs or Small Trees to 25 Feet.—*Amelanchier canadensis, Juniperus chinensis* (C), *Juniperus communis* (C), *Juniperus virginiana* (C).

Large Trees.—Green ash, black locust, hackberry, thornless honey locust, Koelreuteria, cottonwood and other poplars.

Plants for Region 15

Shrubs to 2 Feet or Under.—*Berberis repens* (B).

Shrubs to 4 Feet.—*Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa, Symphoricarpos occidentalis, Symphoricarpos racemosus.*

Shrubs to 6 Feet.—*Berberis thunbergi, Cornus alba, Cornus sanguinea, Cornus stolonifera flaviramea, Ligustrum ibota regelianum, Ribes odoratum, Spiræa prunifolia, Tamarix odessana.*

Shrubs to 8 Feet.—*Viburnum americanum.*

Shrubs to 10 Feet.—*Alnus mitchelliana, Amelanchier alnifolia, Cytisus scoparius, Ligustrum ibota, Physocarpus opulifolius, Syringa chinensis, Tamarix gallica.*

Shrubs to 15 Feet.—*Cornus florida, Cornus paniculata, Hamamelis virginiana, Ligustrum amurense, Sambucus canadensis, Sambucus pubens.*

Shrubs or Small Trees to 20 Feet.—*Amelanchier oblongifolia, Elæagnus angustifolia, Evonymus atropurpureus.*

Shrubs or Small Trees to 25 Feet.—*Juniperus virginiana* (C).

Large Trees.—Green ash, hackberry, Chinese elm, Koelreuteria, cottonwood (staminate form), Carolina poplar, Norway poplar, and ash-leaf maple (when other trees will not succeed).

Plants for Region 16

Shrubs to 2 Feet or Under.—*Berberis repens* (B), *Juniperus communis depressa* (C), *Juniperus prostrata* (C), *Rhus aromatica.*

Shrubs to 4 Feet.—*Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa, Symphoricarpos occidentalis, Symphoricarpos racemosus, Symphoricarpos vulgaris, Viburnum acerifolium.*

Shrubs to 6 Feet.—*Berberis aquifolium* (B), *Berberis thunbergi, Caryopteris mastacanthus, Cephalanthus occidentalis, Cornus alba, Cornus sanguinea, Cornus stolonifera flaviramea, Cydonia japonica, Diervilla rosea, Juniperus sabina* (C), *Kerria japonica, Ligustrum ibota regelianum, Ribes americanum, Ribes odoratum, Rosa carolina, Rosa rugosa, Rosa setigera, Spiræa prunifolia, Spiræa thunbergi, Spiræa vanhouttei, Staphylea bumalda, Stephanandra flexuosa, Tamarix odessana.*

Shrubs to 8 Feet.—*Elæagnus longipes, Forsythia suspensa, Forsythia viridissima, Philadelphus lewisi, Viburnum americanum.*

Shrubs to 10 Feet.—*Alnus mitchelliana, Amelanchier alnifolia, Cytisus scoparius, Hibiscus syriacus, Hydrangea paniculata, Ligustrum ibota, Lonicera ruprechtiana, Lonicera tatarica, Philadelphus coronarius, Philadelphus inodorus, Physocarpus opulifolius, Staphylea trifolia, Syringa chinensis, Tamarix gallica, Thuja occidentalis* (dwarf varieties) (C), *Viburnum opulus.*

Shrubs to 15 Feet.—*Chionanthus virginica, Cornus florida, Colutea arborescens, Cornus mas, Cornus paniculata, Cratægus oxyacantha, Hamamelis virginiana, Hydrangea paniculata grandiflora, Ligustrum amurense, Salix caprea, Sambucus canadensis, Sambucus pubens.*

Shrubs or Small Trees to 20 Feet.—*Amelanchier oblongifolia, Caragana arborescens, Elæagnus angustifolia, Evonymus atropurpureus.*

Shrubs or Small Trees to 25 Feet.—*Cercis canadensis, Cratægus crusgalli, Juniperus chinensis* (C), *Juniperus communis* (C), *Juniperus excelsa* (C), *Juniperus virginiana* (C), *Syringa japonica.*

Large Trees.—Green ash, thornless honey locust, hackberry, black locust, Chinese elm, American elm, Mississippi hackberry, cottonwood, Austrian pine (C) Scotch pine (C), Himalayan cedar (C), Arizona cypress (C).

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Plants for Region 17

Shrubs to 6 Feet.—*Caryopteris mastacanthus, Ribes odoratum, Tamarix odessana.*

Shrubs to 8 Feet.—*Datura arborea* (H), *Elæagnus longipes, Ligustrum sinense.*

Shrubs to 10 Feet.—*Amelanchier alnifolia, Acanthopanax pentaphyllum, Ceanothus thyrsiflorus, Cytisus scoparius, Spartium junceum, Syringa chinensis, Tamarix gallica.*

Shrubs to 15 Feet.—*Hamamelis virginiana, Sambucus canadensis.*

Shrubs or Small Trees to 20 Feet.—*Amelanchier oblongifolia, Elæagnus angustifolia, Melaleuca decussata.*

Shrubs or Small Trees to 25 Feet.—*Juniperus communis* (C), *Ligustrum ovalifolium* (H).

Large Trees.—Parkinsonia, Chinese elm, Texas palmetto (P), Carolina palmetto (P), Canary Island date palm (P), Washington palms (P), athel, cottonwood.

Plants for Region 18

Shrubs to 2 Feet or Under.—*Berberis repens, Ceanothus americanus.*

Shrubs to 4 Feet.—*Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa, Symphoricarpos occidentalis, Symphoricarpos racemosus, Symphoricarpos vulgaris, Viburnum acerifolium.*

Shrubs to 6 Feet.—*Berberis thunbergi, Cornus alba, Cornus sanguinea, Cornus stolonifera flaviramea, Ligustrum ibota regelianum, Ribes americanum, Ribes odoratum, Rosa carolina, Rosa rugosa, Spiræa prunifolia, Spiræa thunbergi, Staphylea bumalda, Tamarix odessana.*

Shrubs to 8 Feet.—*Hydrangea paniculata, Philadelphus lewisi, Viburnum americanum, Viburnum dentatum.*

Shrubs to 10 Feet.—*Alnus mitchelliana, Amelanchier alnifolia, Cytisus scoparius, Ligustrum ibota, Physocarpus opulifolius, Staphylea trifolia, Syringa chinensis, Tamarix gallica.*

Shrubs to 15 Feet.—*Cornus florida, Cornus paniculata, Hamamelis virginiana, Hydrangea paniculata grandiflora, Ligustrum amurense, Sambucus canadensis, Sambucus pubens, Syringa vulgaris.*

Shrubs or Small Trees to 20 Feet.—*Amelanchier oblongifolia, Caragana arborescens, Elæagnus angustifolia, Evonymus atropurpureus, Ptelea trifoliata.*

Shrubs or Small Trees to 25 Feet.—*Amelanchier canadensis, Juniperus communis* (C), *Juniperus virginiana* (C).

Large Trees.—Green ash, black locust, black ash, mossy-cup oak, Chinese elm, Austrian pine (C), Scotch pine (C), Black Hills spruce (C), red cedar (C), arborvitæ (C). Where the above will not grow use ash-leaf maple and willow.

Plants for Region 19

Shrubs to 2 Feet or Under.—*Berberis repens* (B), *Ceanothus americanus, Juniperus communis depressa* (C), *Juniperus prostrata* (C), *Rhus aromatica.*

Shrubs to 4 Feet.—*Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa, Symphoricarpos occidentalis, Symphoricarpos racemosus, Symphoricarpos vulgaris, Viburnum acerifolium.*

Shrubs to 6 Feet.—*Berberis aquifolium* (B), *Berberis thunbergi, Calycanthus floridus, Caryopteris mastacanthus, Cephalanthus occidentalis, Clethra alnifolia, Cornus alba, Cornus sanguinea, Cornus stolonifera flaviramea, Cydonia japonica, Diervilla rosea, Hydrangea arborescens, Hydrangea arborescens sterilis, Juniperus sabina, Kerria*

japonica, Ligustrum ibota regelianum, Ribes americanum, Ribes odoratum, Rosa carolina, Rosa rugosa, Rosa setigera, Spiræa prunifolia, Spiræa thunbergi, Spiræa vanhouttei, Staphylea bumalda, Stephanandra flexuosa, Tamarix odessana.

Shrubs to 8 Feet.—*Elæagnus longipes, Philadelphus lewisi, Viburnum americanum, Viburnum dentatum.*

Shrubs to 10 Feet.—*Alnus mitchelliana, Amelanchier alnifolia, Cytisus scoparius, Exorchorda grandiflora, Hibiscus syriacus, Hydrangea paniculata, Ligustrum ibota, Lonicera ruprechtiana, Lonicera tatarica, Philadelphus coronarius, Philadelphus inodorus, Physocarpus opulifolius, Staphylea trifolia, Syringa chinensis, Tamarix gallica, Thuja occidentalis* (dwarf varieties) (C), *Viburnum opulus.*

Shrubs to 15 feet.—*Chionanthus virginica, Colutea arborescens, Cornus florida, Cornus mas, Cornus paniculata, Hamamelis virginiana, Hydrangea paniculata grandiflora, Ligustrum amurense, Salix caprea, Sambucus canadensis, Sambucus pubens, Syringa vulgaris.*

Shrubs or Small Trees to 20 Feet.—*Amelanchier oblongifolia, Caragana arborescens, Elæagnus angustifolia, Evonymus atropurpureus, Ptelea trifoliata.*

Shrubs or Small Trees to 25 Feet.—*Amelanchier canadensis, Cratægus crusgalli, Juniperus chinensis* (C), *Juniperus communis* (C), *Juniperus excelsa* (C), *Juniperus virginiana* (C), *Syringa japonica.*

Large Trees.—Mossycup oak, Chinese elm, Koelreuteria, hackberry, black locust, thornless honey locust, green ash, red oak, pin oak, sycamore, pecan, Austrian pine (C), Scotch pine (C), red cedar (C), arborvitæ (C).

Plants for Region 20

Shrubs to 2 Feet or Under.—*Berberis repens, Ceanothus americanus, Cotoneaster buxifolia, Cotoneaster microphylla* (B), *Hypericum moserianum* (B), *Juniperus communis depressa* (C), *Juniperus prostrata* (C), *Rhus aromatica.*

Shrubs to 4 Feet.—*Cotoneaster simonsi, Deutzia gracilis, Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa, Symphoricarpos occidentalis, Symphoricarpos vulgaris, Viburnum acerifolium.*

Shrubs to 6 Feet.—*Berberis aquifolium* (B), *Berberis thunbergi, Calycanthus floridus, Caryopteris mastacanthus, Cephalanthus occidentalis, Clethra alnifolia, Cornus alba, Cornus sanguinea, Cornus stolonifera flaviramea, Deutzia crenata* (Pride of Rochester), *Juniperus sabina* (C), *Kerria japonica, Ligustrum ibota regelianum, Rhodotypos kerrioides, Ribes americanum, Ribes odoratum, Rosa carolina, Rosa rugosa, Rosa setigera, Rosa virginiana, Spiræa prunifolia, Spiræa thunbergi, Spiræa vanhouttei, Staphylea bumalda, Stephanandra flexuosa, Tamarix odessana.*

Shrubs to 8 Feet.—*Abelia grandiflora* (H), *Buddleia davidi, Elæagnus longipes, Escallonia montevidensis* (B), *Evonymus alatus, Forsythia suspensa, Forsythia viridissima, Philadelphus lewisi, Viburnum americanum, Viburnum dentatum, Viburnum nudum.*

Shrubs to 10 Feet.—*Æsculus parviflora, Alnus mitchelliana, Acanthopanax pentaphyllum, Cercis japonica, Cytisus scoparius, Exochorda grandiflora, Hydrangea paniculata, Ligustrum ibota, Lonicera ruprechtiana, Lonicera tatarica, Philadelphus coronarius, Philadelphus inodorus, Physocarpus opulifolius, Rhamnus cathartica, Staphylea trifolia, Syringa chinensis, Tamarix gallica,*

Thuja occidentalis (dwarf varieties) (C), *Viburnum opulus.*

Shrubs to 15 Feet.—*Amorpha fruticosa, Chionanthus virginica, Colutea arborescens, Cornus florida, Cornus mas, Cornus paniculata, Cratægus oxyacantha, Hamamelis virginiana, Hydrangea paniculata grandiflora, Ligustrum amurense, Rhus glabra, Salix caprea, Sambucus canadensis, Sambucus pubens, Syringa vulgaris, Viburnum prunifolium.*

Shrubs or Small Trees to 20 Feet.—*Amelanchier oblongifolia, Aralia spinosa, Caragana arborescens, Elæagnus angustifolia, Evonymus atropurpureus, Ptelea trifoliata.*

Shrubs or Small Trees to 25 Feet.—*Cercis canadensis, Cratægus crusgalli, Juniperus chinensis* (C), *Juniperus excelsa* (C), *Juniperus virginiana* (C), *Styrax japonica.*

Large Trees.—Pecan, Mississippi hackberry, winged elm, Chinese elm, mossycup oak, Koelreuteria, London plane, sycamore, willow oak, Texas oak, green ash, black walnut, live oak (B), red cedar (C), Himalayan cedar (C), Arizona cypress (C).

Plants for Region 21

Shrubs to 2 Feet or Under.—*Berberis repens, Ceanothus americanus, Rhus aromatica.*

Shrubs to 4 Feet.—*Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa, Symphoricarpos occidentalis, Symphoricarpos racemosus, Symphoricarpos vulgaris, Viburnum acerifolium.*

Shrubs to 6 Feet.—*Berberis thunbergi, Cornus alba, Cornus sanguinea, Cornus stolonifera flaviramea, Cydonia japonica, Ligustrum ibota regelianum, Ribes americanum, Ribes odoratum, Rosa carolina, Rosa rubiginosa, Rosa rugosa, Spiræa prunifolia, Spiræa thunbergi, Spiræa vanhouttei, Staphylea bumalda, Tamarix odessana.*

Shrubs to 8 Feet.—*Ilex verticillata, Philadelphus lewisi, Viburnum americanum, Viburnum dentatum.*

Shrubs to 10 Feet.—*Alnus mitchelliana, Amelanchier alnifolia, Cytisus scoparius, Hydrangea paniculata, Ligustrum ibota, Philadelphus coronarius, Philadelphus inodorus, Physocarpus opulifolius, Staphylea trifolia, Syringa chinensis, Tamarix gallica, Viburnum opulus.*

Shrubs to 15 Feet.—*Cornus florida, Cornus paniculata, Hamamelis virginiana, Hydrangea paniculata grandiflora, Ligustrum amurense, Sambucus canadensis, Sambucus pubens, Syringa vulgaris.*

Shrubs or Small Trees to 20 Feet.—*Amelanchier oblongifolia, Caragana arborescens, Elæagnus angustifolia, Evonymus atropurpureus, Ptelea trifoliata.*

Shrubs or Small Trees to 25 Feet.—*Amelanchier canadensis, Juniperus virginiana* (C).

Large Trees.—Green ash, American elm, mossycup oak, Chinese elm, red oak, blue ash, Austrian pine (C), Scotch pine (C), red cedar (C), arborvitæ (C).

Plants for Region 22

Shrubs 2 Feet or Under.—*Berberis repens* (B), *Calluna vulgaris* (B), *Ceanothus americanus, Daphne cneorum* (B), *Juniperus communis depressa* (C), *Juniperus prostrata* (C), *Rhus aromatica.*

Shrubs to 4 Feet.—*Daphne mezereum, Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa, Symphoricarpos occidentalis, Symphoricarpos racemosus, Symphoricarpos vulgaris, Viburnum acerifolium.*

Shrubs to 6 Feet.—*Azalea nudiflora, Berberis aquifolium* (B), *Berberis thunbergi, Calycanthus floridus, Caryopteris*

mastacanthus, Cephalanthus occidentalis, Clethra alnifolia, Cornus alba, Cornus sanguinea, Cornus stolonifera flaviramea, Cydonia japonica, Diervilla rosea, Hydrangea arborescens, Hydrangea arborescens sterilis, Juniperus sabina (C), *Kerria japonica, Ligustrum ibota regelianum, Rhodotypos kerrioides, Ribes americanum, Ribes odoratum, Rosa carolina, Rosa rubiginosa, Rosa rugosa, Rosa setigera, Rosa virginiana, Spiræa prunifolia, Spiræa thunbergi, Spiræa vanhouttei, Staphylea bumalda, Stephanandra flexuosa.*

Shrubs to 8 Feet.—*Elæagnus longipes, Evonymus alatus, Forsythia suspensa, Forsythia viridissima, Ilex verticillata, Myrica carolinensis* (H), *Philadelphus lewisi, Prunus pumila, Viburnum americanum, Viburnum dentatum, Viburnum nudum, Viburnum tomentosum.*

Shrubs to 10 Feet.—*Alnus mitchelliana, Amelanchier alnifolia, Cercis japonica, Cytisus scoparius, Exochorda grandiflora, Hibiscus syriacus, Ligustrum ibota, Ligustrum japonicum* (B), *Lonicera reprechtiana, Lonicera tatarica, Lycium chinense, Philadelphus coronarius, Philadelphus inodorus, Physocarpus opulifolius, Rhamnus cathartica, Staphylea trifolia, Syringa chinensis, Thuja occidentalis* (dwarf varieties) (C), *Thuja orientalis* (dwarf varieties) (C), *Viburnum opulus.*

Shrubs to 15 Feet.—*Amorpha fruticosa, Chionanthus virginica, Colutea arborescens, Cornus florida, Cornus paniculata, Hamamelis virginiana, Hydrangea paniculata grandiflora, Ligustrum amurense, Prunus pissardi, Rhus cotinus, Rhus glabra, Salix caprea, Sambucus canadensis, Sambucus pubens, Syringa vulgaris, Viburnum prunifolium.*

Shrubs or Small Trees to 20 Feet.—*Amelanchier oblongifolia, Caragana arborescens, Elæagnus angustifolia, Evonymus atropurpureus, Ptelea trifoliata.*

Shrubs or Small Trees to 25 Feet.—*Amelanchier canadensis, Cercis canadensis, Cratægus crusgalli, Juniperus chinensis* (C), *Juniperus excelsa* (C), *Juniperus virginiana* (C), *Styrax japonica, Syringa japonica.*

Large Trees.—American elm, red oak, black walnut, sugar maple, sycamore, mossycup oak, white ash, green ash, white oak, Austrian pine (C), Scotch pine (C), arborvitæ (C), red cedar (C).

Plants for Region 23

Shrubs to 2 Feet or Under.—*Andromeda polifolia* (B), *Berberis repens* (B), *Calluna vulgaris* (B), *Ceanothus americanus, Chamædaphne calyculata* (B), *Rhus aromatica.*

Shrubs to 4 Feet.—*Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa, Symphoricarpos occidentalis, Symphoricarpos racemosus, Symphoricarpos vulgaris, Viburnum acerifolium.*

Shrubs to 6 Feet.—*Azalea nudiflora, Berberis aquifolium* (B), *Berberis thunbergi, Calycanthus floridus, Cephalanthus occidentalis, Clethra alnifolia, Cornus alba, Cornus sanguinea, Cornus stolonifera flaviramea, Cydonia japonica, Hydrangea arborescens, Hydrangea arborescens sterilis, Ligustrum ibota regelianum, Rhodotypos kerrioides, Ribes americanum, Ribes odoratum, Rosa carolina, Rosa rubiginosa, Rosa rugosa, Rosa setigera, Rosa virginiana, Spiræa prunifolia, Spiræa thunbergi, Spiræa vanhouttei, Staphylea bumalda, Stephanandra flexuosa.*

Shrubs to 8 Feet.—*Elæagnus longipes, Forsythia suspensa, Ilex verticillata, Myrica carolinensis* (H), *Philadelphus lewisi, Prunus pumila, Viburnum americanum, Viburnum dentatum, Viburnum tomentosum.*

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Shrubs to 10 Feet.—*Alnus mitchelliana, Amelanchier alnifolia, Azalea calendulacea, Cercis japonica, Cytisus scoparius, Hibiscus syriacus, Hydrangea paniculata, Ligustrum ibota, Lonicera ruprechtiana, Lonicera tatarica, Lycium chinense, Philadelphus coronarius, Philadelphus inodorus, Physocarpus opulifolius, Prunus maritima, Staphylea trifolia, Syringa chinensis, Thuja occidentalis* (dwarf varieties) (C), *Thuja orientalis* (dwarf varieties) (C), *Viburnum opulus.*

Shrubs to 15 Feet.—*Cornus florida, Cornus mas, Cornus paniculata, Hamamelis virginiana, Hydrangea paniculata grandiflora, Ligustrum amurense, Prunus pissardi, Rhus cotinus, Sambucus canadensis, Sambucus pubens.*

Shrubs or Small Trees to 20 Feet.—*Amelanchier oblongifolia, Caragana arborescens, Elæagnus angustifolia, Evonymus atropurpureus, Ptelea trifoliata.*

Shrubs or Small Trees to 25 Feet.—*Amelanchier canadensis, Cercis canadensis, Cratægus crusgalli, Juniperus chinensis* (C), *Juniperus virginiana* (C), *Syringa japonica.*

Large Trees.—American elm, red oak, mossycup oak, red maple, green ash, basswood, sugar maple, Chinese elm, Norway maple, honey locust, Austrian pine (C), arborvitæ (C), white spruce (C), white pine (C).

Plants for Region 24

Shrubs to 2 Feet or Under.—*Andromeda polifolia* (B), *Berberis repens* (B), *Calluna vulgaris* (B), *Ceanothus americanus, Chamædaphne calyculata* (B), *Daphne cneorum* (B), *Rhus aromatica.*

Shrubs to 4 Feet.—*Daphne mezereum, Kalmia angustifolia* (B), *Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa, Symphoricarpos occidentalis, Symphoricarpos racemosus, Symphoricarpos vulgaris, Viburnum acerifolium.*

Shrubs to 6 Feet.—*Azalea nudiflora, Berberis aquifolium* (B), *Berberis thunbergi, Calycanthus floridus, Caryopteris mastacanthus, Cephalanthus occidentalis, Clethra alnifolia, Cornus alba, Cornus sanguinea, Cornus stolonifera flaviramea, Cydonia japonica, Diervilla rosea, Hydrangea arborescens, Hydrangea arborescens sterilis, Juniperus squamata, Kalmia latifolia* (B), *Kerria japonica, Ligustrum ibota regelianum, Rhodotypos kerrioides, Ribes americanum, Ribes odoratum, Rosa carolina, Rosa rugosa, Rosa setigera, Rosa virginiana, Spiræa prunifolia, Spiræa thunbergi, Spiræa vanhouttei, Staphylea bumalda, Stephanandra flexuosa.*

Shrubs to 8 Feet.—*Cephalotaxus pedunculata* (C), *Elæagnus longipes, Evonymus alatus, Forsythia suspensa, Ilex glabra* (B), *Ilex verticillata, Myrica carolinensis* (H), *Philadelphus lewisi, Prunus pumila, Viburnum americanum, Viburnum dentatum, Viburnum tomentosum.*

Shrubs to 10 Feet.—*Alnus mitchelliana, Amelanchier alnifolia, Azalea calendulacea, Cephalotaxus drupacea sinensis* (C), *Cercis japonica, Cytisus scoparius, Exochorda grandiflora, Hibiscus syriacus, Hydrangea paniculata, Ligustrum ibota, Ligustrum japonicum, Lonicera ruprechtiana, Lonicera tatarica, Lycium chinense, Philadelphus coronarius, Philadelphus inodorus, Physocarpus opulifolius, Pinus montana mughus* (C), *Prunus maritima* (C), *Rhamnus cathartica, Staphylea trifolia, Syringa chinensis, Thuja occidentalis* (dwarf varieties) (C), *Thuja orientalis* (dwarf varieties) (C), *Viburnum opulus.*

Shrubs to 15 Feet.—*Chionanthus virginica, Colutea arborescens, Cornus florida, Cornus mas, Cornus paniculata, Hamamelis virginiana, Hydrangea paniculata grandiflora, Ligustrum amurense, Prunus pissardi, Chamæcyparis pisifera filifera* (C), *Chamæcyparis pisifera* (C), *Chamæ-*

cyparis pisifera plumosa (C), *Chamæcyparis obtusa* (C), *Chamæcyparis pisifera squarrosa* (C), *Rhododendron maximum* (B), *Rhus cotinus, Rhus glabra, Salix caprea, Sambucus canadensis, Sambucus pubens, Syringa vulgaris, Viburnum prunifolium.*

Shrubs or Small Trees to 20 Feet.—*Amelanchier oblongifolia, Caragana arborescens, Elæagnus angustifolia, Evonymus atropurpureus, Ptelea trifoliata.*

Shrubs or Small Trees to 25 Feet.—*Amelanchier canadensis, Cercis canadensis, Cratægus crusgalli, Juniperus chinensis* (C), *Juniperus virginiana* (C), *Styrax japonica, Syringa japonica.*

Large Trees.—Sugar maple, American elm, red oak, black walnut, basswood, white oak, white ash, mossycup oak, white pine (C), hemlock (C), Austrian pine (C), arborvitæ (C).

Plants for Region 25

Shrubs to 2 Feet or Under.—*Andromeda polifolia* (B), *Berberis repens* (B), *Calluna vulgaris* (B), *Ceanothus americanus, Chamædaphne calyculata* (B), *Cotoneaster buxifolia, Cotoneaster microphylla* (B), *Daphne cneorum* (B), *Hypericum moserianum* (B), *Juniperus communis depressa* (C), *Juniperus prostrata* (C), *Rhus aromatica.*

Shrubs to 4 Feet.—*Azalea amœna* (B), *Callicarpa purpurea, Cotoneaster simonsi, Daphne mezereum, Deutzia gracilis, Evonymus radicans* (B), *Kalmia angustifolia* (B), *Robinia hispida, Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa, Symphoricarpos occidentalis, Symphoricarpos racemosus, Symphoricarpos vulgaris, Viburnum acerifolium.*

Shrubs to 6 Feet.—*Azalea nudiflora, Berberis aquifolium* (B), *Berberis thunbergi, Buxus sempervirens suffruticosa* (B), *Callicarpa americana, Calycanthus floridus, Caryopteris mastacanthus, Cephalanthus occidentalis, Clethra alnifolia, Cornus alba, Cornus sanguinea, Cornus stolonifera flaviramea, Cydonia japonica, Deutzia scabra crenata* (Pride of Rochester and others), *Diervilla rosea, Hydrangea arborescens, Hydrangea arborescens sterilis, Hydrangea quercifolia, Juniperus sabina* (C), *Juniperus squamata* (C), *Kerria japonica, Ligustrum ibota regelianum, Lonicera morrowi, Rhodotypos kerrioides, Ribes americanum, Ribes odoratum, Rosa carolina, Rosa rubiginosa, Rosa rugosa, Rosa setigera, Rosa virginiana, Spiræa prunifolia, Spiræa vanhouttei, Spiræa thunbergi, Staphylea bumalda, Stephanandra flexuosa, Tamarix odessana.*

Shrubs to 8 Feet.—*Aucuba japonica* (B), *Berberis ilicifolia* (B), *Buddleia davidi, Cephalotaxus pedunculata* (C), *Elæagnus longipes, Evonymus alatus, Evonymus japonicus* (B), *Forsythia suspensa, Forsythia viridissima, Ilex glabra* (B), *Ilex verticillata, Kalmia latifolia* (B), *Lonicera fragrantissima, Myrica carolinensis, Philadelphus lewisi, Prunus pumila, Viburnum dentatum, Viburnum nudum, Viburnum tomentosum.*

Shrubs to 10 Feet.—*Æsculus parviflora, Alnus mitchelliana, Amelanchier alnifolia, Acanthopanax pentaphyllum, Azalea calendulacea, Cephalotaxus drupacea sinensis* (C), *Cercis japonica, Cytisus scoparius, Exochorda grandiflora, Hibiscus syriacus, Hydrangea paniculata, Ligustrum ibota, Ligustrum japonicum, Lonicera ruprechtiana, Lonicera tatarica, Lycium chinensis, Philadelphus coronarius, Philadelphus inodorus, Physocarpus opulifolius, Pinus montana mughus* (C), *Prunus maritima* (C), *Rhamnus cathartica, Staphylea trifolia, Syringa chinensis, Syringa persica, Tamarix gallica, Thuja occidentalis*

(dwarf varieties) (C), *Thuja orientalis* (dwarf varieties) (C), *Viburnum opulus.*

Shrubs to 15 Feet.—*Amorpha fruticosa, Chionanthus virginica, Colutea arborescens, Cornus florida, Cornus mas, Cornus paniculata, Cratægus oxyacantha, Hamamelis virginiana, Hydrangea paniculata grandiflora, Ligustrum amurense, Magnolia glauca* (H), *Magnolia stellata, Prunus pissardi, Chamæcyparis obtusa* (C), *Chamæcyparis pisifera* (C), *Chamæcyparis pisifera filifera* (C), *Chamæcyparis pisifera plumosa* (C), *Chamæcyparis pisifera squarrosa* (C), *Rhododendron maximum* (B), *Rhus cotinus, Rhus glabra, Salix caprea, Sambucus canadensis, Sambucus pubens, Syringa vulgaris, Viburnum prunifolium.*

Shrubs or Small Trees to 20 Feet.—*Amelanchier oblongifolia, Aralia spinosa, Caragana arborescens, Elæagnus angustifolia, Evonymus atropurpureus, Ilex crenata, Ptelea trifoliata.*

Shrubs or Small Trees to 25 Feet.—*Amelanchier canadensis, Buxus sempervirens* (B), *Cercis canadensis, Cratægus crusgalli, Juniperus chinensis* (C), *Juniperus communis* (C), *Juniperus excelsa* (C), *Juniperus virginiana* (C), *Styrax japonica, Syringa japonica.*

Large Trees.—Red oak, sugar maple, tulip tree, black walnut, sycamore, American elm, mossycup oak, pecan, sweet gum, white oak, pines (C), spruces (C).

Plants for Region 26

Shrubs to 2 Feet or Under.—*Andromeda polifolia* (B), *Berberis repens* (B), *Calluna vulgaris* (B), *Ceanothus americanus, Chamædaphne calyculata* (B), *Erica carnea* (B), *Erica vagans* (B), *Juniperus communis depressa* (C), *Juniperus prostrata* (C), *Rhus aromatica.*

Shrubs to 4 Feet.—*Kalmia angustifolia* (B), *Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa, Symphoricarpos racemosus, Symphoricarpos vulgaris, Viburnum acerifolium.*

Shrubs to 6 Feet.—*Azalea nudiflora, Berberis thunbergi, Cephalanthus occidentalis, Clethra alnifolia, Cornus alba, Cornus sanguinea, Cornus stolonifera flaviramea, Cydonia japonica, Hydrangea arborescens, Juniperus squamata* (C), *Ligustrum ibota regelianum, Ribes americanum, Ribes odoratum, Rosa carolina, Rosa rugosa, Rosa setigera, Rosa virginiana, Spiræa prunifolia, Spiræa vanhouttei, Staphylea bumalda.*

Shrubs to 8 Feet.—*Elæagnus longipes, Forsythia suspensa, Ilex verticillata, Kalmia latifolia* (B), *Myrica carolinensis* (H), *Philadelphus lewisi, Prunus pumila, Viburnum americanum, Viburnum dentatum, Viburnum tomentosum.*

Shrubs to 10 Feet.—*Alnus mitchelliana, Amelanchier alnifolia, Azalea calendulacea, Cytisus scoparius, Hibiscus syriacus, Hydrangea paniculata, Ligustrum ibota, Lonicera ruprechtiana, Lonicera tatarica, Lycium chinense, Philadelphus coronarius, Physocarpus opulifolius, Pinus montana mughus* (C), *Prunus maritima* (C), *Rhamnus cathartica, Staphylea trifolia, Syringa chinensis, Thuja occidentalis* (dwarf varieties) (C), *Viburnum opulus.*

Shrubs to 15 Feet.—*Cornus florida, Cornus mas, Cornus paniculata, Hamamelis virginiana, Hydrangea paniculata grandiflora, Ligustrum amurense, Prunus pissardi, Rhododendron maximum* (B), *Rhus glabra, Sambucus canadensis, Sambucus pubens, Syringa vulgaris.*

Shrubs or Small Trees to 20 Feet.—*Amelanchier oblongifolia, Caragana arborescens, Elæagnus angustifolia, Evonymus atropurpureus, Ptelea trifoliata.*

Shrubs or Small Trees to 25 Feet.—*Amelanchier canadensis, Cratægus crusgalli, Juniperus chinensis* (C), *Juniperus communis* (C), *Juniperus virginiana* (C).

Large Trees.—American elm, red maple, sugar maple, red oak, white oak, basswood, shagbark hickory, canoe birch, white pine (C), firs (C), spruces (C), hemlock (C).

Plants for Region 27

Shrubs to 2 Feet or Under.—*Andromeda polifolia* (B), *Berberis repens* (B), *Calluna vulgaris* (B), *Ceanothus americanus, Chamædaphne calyculata, Juniperus communis depressa* (C), *Juniperus prostrata* (C), *Rhus aromatica.*

Shrubs to 4 Feet.—*Azalea amœna, Daphne mezereum, Deutzia gracilis, Evonymus radicans* (B), *Kalmia angustifolia* (B), *Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa, Symphoricarpos occidentalis, Symphoricarpos racemosus, Symphoricarpos vulgaris, Viburnum acerifolium.*

Shrubs to 6 Feet.—*Azalea nudiflora, Berberis aquifolium* (B), *Berberis thunbergi, Calycanthus floridus, Caryopteris mastacanthus, Cephalanthus occidentalis, Clethra alnifolia, Cornus alba, Cornus sanguinea, Cornus stolonifera flaviramea, Cydonia japonica, Diervilla rosea, Hydrangea arborescens, Hydrangea arborescens sterilis, Juniperus sabina* (C), *Juniperus squamata* (C), *Kerria japonica, Ligustrum ibota regelianum, Lonicera morrowi, Rhodotypos kerrioides, Ribes americanum, Ribes odoratum, Rosa carolina, Rosa rubiginosa, Rosa rugosa, Rosa setigera, Rosa virginiana, Spiræa prunifolia, Spiræa thunbergi, Spiræa vanhouttei, Staphylea bumalda, Stephanandra flexuosa.*

Shrubs to 8 Feet.—*Cephalotaxus pedunculata* (C), *Elæagnus longipes, Evonymus alatus, Forsythia suspensa, Forsythia viridissima, Ilex glabra* (B), *Ilex verticillata, Kalmia latifolia* (B), *Myrica carolinensis* (H), *Philadelphus lewisi, Prunus pumila, Viburnum americanum, Viburnum dentatum, Viburnum tomentosum.*

Shrubs to 10 Feet.—*Alnus mitchelliana, Amelanchier alnifolia, Azalea calendulacea, Cephalotaxus drupacea sinensis* (C), *Cercis japonica, Cytisus scoparius, Exochorda grandiflora, Hibiscus syriacus, Hydrangea paniculata, Ligustrum ibota, Lonicera ruprechtiana, Lonicera tatarica, Lycium chinense, Philadelphus coronarius, Philadelphus inodorus, Physocarpus opulifolius, Pinus montana mughus* (C), *Prunus maritima, Rhamnus cathartica, Rhododendron catawbiense* (B), *Staphylea trifolia, Syringa chinensis, Syringa persica, Thuja occidentalis* (dwarf varieties) (C), *Thuja orientalis* (dwarf varieties) (C), *Viburnum opulus.*

Shrubs to 15 Feet.—*Chamæcyparis obtusa* (C), *Chamæcyparis pisifera* (C), *Chamæcyparis pisifera filifera* (C), *Chamæcyparis pisifera plumosa* (C), *Chamæcyparis pisifera squarrosa* (C), *Chionanthus virginica, Colutea arborescens, Cornus florida, Cornus mas, Cornus paniculata, Cratægus oxyacantha, Hamamelis virginiana, Hydrangea paniculata grandiflora, Ligustrum amurense, Magnolia glauca* (H), *Magnolia stellata, Prunus pissardi, Pyracantha coccinea lalandi* (H), *Rhododendron maximum* (B), *Rhus cotinus, Rhus glabra, Salix caprea, Sambucus canadensis, Sambucus pubens, Syringa vulgaris, Viburnum prunifolium.*

Shrubs or Small Trees to 20 Feet.—*Amelanchier oblongifolia, Caragana arborescens, Elæagnus angustifolia, Evonymus atropurpureus, Ptelea trifoliata.*

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Shrubs or Small Trees to 25 Feet.—*Amelanchier canadensis, Cercis canadensis, Cratægus crusgalli, Juniperus chinensis* (C), *Juniperus communis* (C), *Juniperus excelsa* (C), *Juniperus virginiana* (C), *Styrax japonica, Syringa japonica.*

Large Trees.—Red oak, white oak, sugar maple, American elm, tulip tree, basswood, white pine (C), hemlock (C).

Plants for Region 28

Shrubs to 2 Feet or Under.—*Andromeda polifolia* (B), *Berberis repens* (B), *Calluna vulgaris* (B), *Ceanothus americanus, Cotoneaster buxifolia, Daphne cneorum* (B), *Hypericum moserianum* (B), *Juniperus communis depressa* (C), *Juniperus prostrata* (C), *Rhus aromatica.*

Shrubs to 4 Feet.—*Azalea amœna, Callicarpa purpurea, Cotoneaster simonsi, Daphne mezereum, Deutzia gracilis, Evonymus radicans* (B), *Kalmia angustifolia* (B), *Pieris floribunda* (B), *Robinia hispida, Rosa bracteata, Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa, Symphoricarpos occidentalis, Symphoricarpos racemosus, Symphoricarpos vulgaris, Viburnum acerifolium.*

Shrubs to 6 Feet.—*Azalea indica, Azalea nudiflora, Berberis aquifolium* (B), *Berberis thunbergi, Buxus sempervirens suffruticosa* (B), *Callicarpa americana, Calycanthus floridus, Caryopteris mastacanthus, Cephalanthus occidentalis, Clethra alnifolia, Cornus alba, Cornus sanguinea, Cornus stolonifera flaviramea, Cydonia japonica, Deutzia crenata* (Pride of Rochester and others), *Diervilla rosea, Hydrangea arborescens, Hydrangea arborescens sterilis, Hydrangea quercifolia, Jasminum nudiflorum, Juniperus sabina* (C), *Juniperus squamata* (C), *Kerria japonica, Leucothoe catesbæi* (B), *Ligustrum ibota regelianum, Lonicera morrowi, Rhodotypos kerrioides, Ribes odoratum, Rosa carolina, Rosa rubiginosa, Rosa rugosa, Rosa setigera, Rosa virginiana, Spiræa prunifolia, Spiræa thunbergi, Spiræa vanhouttei, Staphylea bumalda, Stephanandra flexuosa, Tamarix odessana.*

Shrubs to 8 Feet.—*Abelia grandiflora* (B), *Aucuba japonica* (B), *Berberis ilicifolia* (B), *Buddleia davidi, Cephalotaxus pedunculata* (C), *Elæagnus longipes, Elæagnus macrophylla* (B), *Elæagnus pungens* (B), *Escallonia montevidensis* (B), *Evonymus alatus, Evonymus japonicus* (B), *Forsythia suspensa, Forsythia viridissima, Hydrangea hortensis, Ilex glabra* (B), *Ilex verticillata, Kalmia latifolia* (B), *Lonicera fragrantissima, Myrica carolinensis* (H), *Philadelphus lewisi, Prunus pumila, Viburnum americanum, Viburnum dentatum, Viburnum nudum, Viburnum tomentosum.*

Shrubs to 10 Feet.—*Æsculus parviflora, Alnus mitchelliana, Acanthopanax pentaphyllum, Azalea calendulacea, Cephalotaxus drupacea sinensis* (C), *Cercis japonica* (C), *Cytisus scoparius, Exochorda grandiflora, Hibiscus syriacus, Hydrangea paniculata, Ligustrum ibota, Ligustrum japonicum, Lonicera ruprechtiana, Lonicera tatarica, Lycium chinense, Philadelphus coronarius, Philadelphus inodorus, Physocarpus opulifolius, Pinus montana mughus* (C), *Prunus maritima, Rhamnus cathartica, Rhododendron catawbiense* (B), *Rosa lævigata, Staphylea trifolia, Syringa chinensis, Syringa persica, Tamarix gallica, Thuja occidentalis* (dwarf varieties) (C), *Thuja orientalis* (dwarf varieties) (C), *Viburnum opulus.*

Shrubs to 15 Feet.—*Amorpha fruticosa, Chionanthus virginica, Colutea arborescens, Cornus florida, Cornus mas, Cornus paniculata, Hamamelis virginiana, Hydrangea paniculata grandiflora, Ilex vomitoria* (B), *Ligustrum amurense, Magnolia glauca* (B), *Prunus pissardi, Pyra-*

cantha coccinea lalandi (H), *Chamæcyparis obtusa* (C), *Chamæcyparis pisifera* (C), *Chamæcyparis pisifera filifera* (C), *Chamæcyparis pisifera plumosa* (C), *Chamæcyparis pisifera squarrosa* (C), *Ligustrum lucidum* (B), *Magnolia stellata, Osmanthus aquifolium* (B), *Punica granatum* (B), *Rhododendron maximum* (B), *Rhus cotinus, Rhus glabra, Salix caprea, Sambucus canadensis, Sambucus pubens, Syringa vulgaris, Viburnum prunifolium.*

Shrubs or Small Trees to 20 Feet.—*Amelanchier oblongifolia, Aralia spinosa, Caragana arborescens, Elæagnus angustifolia, Evonymus atropurpureus, Ilex crenata* (B), *Ptelea trifoliata.*

Shrubs or Small Trees to 25 Feet.—*Amelanchier canadensis, Buxus sempervirens* (B), *Cercis canadensis, Cratægus crusgalli, Ilex aquifolium* (B), *Juniperus chinensis* (C), *Juniperus communis* (C), *Juniperus excelsa* (C), *Juniperus virginiana* (C), *Ligustrum ovalifolium* (H), *Styrax japonica.*

Large Trees.—Red oak, white oak, tulip, willow oak, red maple, Norway maple, sweet gum, pecan, black walnut, sycamore, basswood, sour gum, holly, magnolia, laurel oak (B), live oak (B).

Plants for Region 29

Shrubs to 2 Feet or Under.—*Berberis repens* (B), *Calluna vulgaris* (B), *Ceanothus americanus, Cotoneaster buxifolia, Cotoneaster microphylla* (B), *Daphne cneorum* (B), *Hypericum moserianum* (B), *Juniperus communis depressa* (C), *Juniperus prostrata* (C), *Rhus aromatica.*

Shrubs to 4 Feet.—*Azalea amœna* (B), *Berberis thunbergi, Callicarpa purpurea, Cotoneaster simonsi, Daphne mezereum, Deutzia gracilis, Evonymus radicans* (B), *Kalmia angustifolia* (B), *Pieris floribunda* (B), *Robinia hispida, Rosa bracteata, Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa, Symphoricarpos occidentalis, Symphoricarpos racemosus, Symphoricarpos vulgaris, Viburnum acerifolium.*

Shrubs to 6 Feet.—*Azalea indica* (B), *Azalea nudiflora, Berberis aquifolium* (B), *Buxus sempervirens suffruticosa* (B), *Callicarpa americana, Calycanthus floridus, Caryopteris mastacanthus, Cephalanthus occidentalis, Clethra alnifolia, Cornus alba, Cornus sanguinea, Cornus stolonifera flaviramea, Cydonia japonica, Deutzia crenata, Diervilla rosea, Hydrangea arborescens, Hydrangea arborescens sterilis, Hydrangea quercifolia, Jasminum nudiflorum, Juniperus sabina* (C), *Juniperus squamata* (C), *Kerria japonica, Leucothoe catesbæi* (B), *Ligustrum ibota regelianum, Lonicera morrowi, Nandina japonica* (B), *Rhodotypos kerrioides, Ribes odoratum, Rosa carolina, Rosa rubiginosa, Rosa rugosa, Rosa setigera, Rosa virginiana, Spiræa prunifolia, Spiræa thunbergi, Spiræa vanhouttei, Staphylea bumalda, Stephanandra flexuosa, Tamarix odessana.*

Shrubs to 8 Feet.—*Abelia grandiflora* (B), *Aucuba japonica* (B), *Berberis ilicifolia* (B), *Buddleia davidi, Cephalotaxus pedunculata* (C), *Elæagnus longipes, Elæagnus macrophylla* (B), *Elæagnus pungens* (B), *Escallonia montevidensis* (B), *Evonymus alatus, Evonymus japonicus* (B), *Forsythia suspensa, Forsythia viridissima, Gardenia jasminoides* (B), *Hydrangea hortensis, Ilex glabra* (B), *Ilex verticillata, Kalmia latifolia* (B), *Ligustrum sinense, Lonicera fragrantissima, Myrica carolinensis* (H), *Philadelphus lewisi, Viburnum americanum, Viburnum dentatum, Viburnum nudum, Viburnum tomentosum.*

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Shrubs to 10 Feet.—*Æsculus parviflora, Alnus mitchelliana, Amelanchier alnifolia, Acanthopanax pentaphyllum, Azalea calendulacea, Cephalotaxus drupacea sinensis* (C), *Cercis japonica, Cytisus scoparius, Exochorda grandiflora, Hibiscus syriacus, Hydrangea paniculata, Ligustrum ibota, Ligustrum japonicum* (B), *Lonicera ruprechtiana, Lonicera tatarica, Lycium chinense, Philadelphus coronarius, Philadelphus inodorus, Physocarpus opulifolius, Pittosporum tobira* (B), *Prunus maritima, Rhamnus cathartica, Rosa lævigata, Staphylea trifolia, Syringa chinensis, Syringa persica, Tamarix gallica, Thuja occidentalis* (dwarf varieties) (C), *Thuja orientalis* (dwarf varieties) (C), *Viburnum opulus.*

Shrubs to 15 Feet.—*Amorpha fruticosa, Chionanthus virginica, Colutea arborescens, Cornus florida, Cornus mas, Cornus paniculata, Hamamelis virginiana, Hydrangea paniculata grandiflora, Ilex vomitoria* (B), *Ligustrum amurense, Magnolia stellata, Magnolia glauca* (B), *Osmanthus fragrans* (B), *Prunus pissardi, Pyracantha coccinea lalandi* (H), *Chamæcyparis obtusa* (C), *Chamæcyparis pisifera* (C), *Chamæcyparis pisifera filifera* (C), *Chamæcyparis pisifera plumosa* (C), *Chamæcyparis pisifera squarrosa* (C), *Ligustrum lucidum* (B), *Osmanthus aquifolium* (B), *Photinia serrulata* (B), *Punica granatum* (B), *Rhododendron maximum* (B), *Rhus cotinus, Rhus glabra, Salix caprea, Sambucus canadensis, Sambucus pubens, Syringa vulgaris, Viburnum prunifolium.*

Shrubs or Small Trees to 20 Feet.—*Amelanchier oblongifolia, Aralia spinosa, Camellia japonica* (B), *Caragana arborescens, Evonymus atropurpureus, Ilex crenata* (B), *Jasminum humile, Pieris japonica* (B), *Ptelea trifoliata, Thea sinensis* (B).

Shrubs or Small Trees to 25 Feet.—*Amelanchier canadensis, Buxus sempervirens* (B), *Cercis canadensis, Cratægus crusgalli, Ilex aquifolium* (B), *Juniperus chinensis* (C), *Juniperus excelsa* (C), *Juniperus virginiana* (C), *Lagerstrœmia indica, Ligustrum ovalifolium* (H), *Prunus caroliniana* (B), *Styrax japonica, Syringa japonica.*

Large Trees.—Live oak (B), willow oak, pecan, sweet gum, laurel oak (B), Spanish oak, red oak, tulip tree, American elm, sycamore, evergreen magnolia (B), holly (B), Himalayan cedar (C).

Plants for Region 30

Shrubs to 2 Feet or Under.—*Cotoneaster buxifolia, Cotoneaster microphylla* (B), *Hypericum moserianum* (B), *Juniperus communis depressa* (C), *Juniperus prostrata* (C), *Rhus aromatica.*

Shrubs to 4 Feet.—*Callicarpa purpurea, Cistus ladaniferus* (B), *Cotoneaster simonsi, Deutzia gracilis, Evonymus radicans* (B), *Pieris floribunda* (B), *Robinia hispida, Rosa bracteata, Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa.*

Shrubs to 6 Feet.—*Azalea nudiflora, Berberis thunbergi, Buxus sempervirens suffruticosa* (B), *Callicarpa americana, Calycanthus floridus, Caryopteris mastacanthus, Clethra alnifolia, Cornus sanguinea, Deutzia crenata, Diervilla rosea, Hydrangea arborescens, Hydrangea arborescens sterilis, Hydrangea quercifolia, Jasminum nudiflorum, Juniperus sabina* (C), *Kerria japonica, Ligustrum ibota regelianum, Lonicera morrowi, Nandina japonica* (B), *Rhodotypos kerrioides, Rosa carolina, Rosa rubiginosa, Rosa setigera, Spiræa prunifolia, Spiræa thunbergi, Spiræa vanhouttei, Staphylea bumalda, Stephanandra flexuosa, Tamarix odessana, Viburnum suspensum.*

Shrubs to 8 Feet.—*Abelia grandiflora* (B), *Aucuba japonica* (B), *Buddleia davidi, Datura arborea* (H), *Escallonia montevidensis* (B), *Evonymus alatus, Evonymus*

japonicus (B), *Forsythia suspensa, Forsythia viridissima, Gardenia jasminoides* (B), *Hydrangea hortensis, Ilex glabra* (B), *Ilex verticillata, Kalmia latifolia* (B), *Ligustrum sinense, Lonicera fragrantissima, Myrica carolinensis* (H), *Philadelphus lewisi, Viburnum nudum, Viburnum tinus* (B).

Shrubs to 10 Feet.—*Æsculus parviflora, Amelanchier alnifolia, Acanthopanax pentaphyllum, Azalea calendulacea, Ceanothus thyrsiflorus, Hibiscus syriacus, Hydrangea paniculata, Ligustrum ibota, Ligustrum japonicum* (B), *Lonicera ruprechtiana, Lonicera tatarica, Lycium chinense, Myrtus communis* (B), *Philadelphus coronarius, Philadelphus inodorus, Physocarpus opulifolius, Pittosporum tobira* (B), *Rosa lævigata, Spartium junceum, Staphylea trifolia, Syringa chinensis, Tamarix gallica.*

Shrubs to 15 Feet.—*Amorpha fruticosa, Cornus florida, Cornus mas, Hamamelis virginiana, Hydrangea paniculata grandiflora, Ilex vomitoria* (B), *Ligustrum amurense, Ligustrum lucidum* (B), *Magnolia glauca* (B), *Magnolia stellata, Nerium oleander* (B), *Osmanthus aquifolium* (B), *Osmanthus fragrans* (B), *Photinia serrulata* (B), *Punica granatum* (B), *Pyracantha coccinea lalandi* (H), *Salix caprea, Sambucus canadensis, Sambucus pubens, Syringa vulgaris, Viburnum prunifolium.*

Shrubs or Small Trees to 20 Feet.—*Amelanchier oblongifolia, Aralia spinosa, Camellia japonica* (B), *Caragana arborescens, Evonymus atropurpureus, Ilex crenata* (B), *Jasminum humile, Pieris japonica* (B), *Ptelea trifoliata, Thea sinensis* (B).

Shrubs or Small Trees to 25 Feet.—*Amelanchier canadensis, Buxus sempervirens* (B), *Ilex aquifolium* (B), *Juniperus chinensis* (C), *Juniperus excelsa* (C), *Juniperus virginiana* (C), *Lagerstrœmia indica, Ligustrum ovalifolium, Pittosporum undulatum* (B), *Prunus ilicifolia* (B), *Prunus caroliniana* (B), *Styrax japonica, Syringa japonica.*

Large Trees.—Live oak (B), willow oak, sweet gum, pecan, red oak, Spanish oak, sycamore, holly (B), magnolia (B), laurel oak (B), palmetto (B), Washington palms (P), Canary Island date palm (P), cypress (C).

Plants for Region 31

Shrubs to 2 Feet or Under.—*Cotoneaster buxifolia, Cotoneaster microphylla* (B), *Hypericum moserianum* (B).

Shrubs to 4 Feet.—*Callicarpa purpurea, Cistus ladaniferus* (B), *Cotoneaster simonsi, Evonymus radicans* (B), *Pieris floribunda* (B), *Spiræa bumalda, Spiræa bumalda* Anthony Waterer, *Spiræa japonica, Spiræa tomentosa.*

Shrubs to 6 Feet.—*Buxus sempervirens suffruticosa* (B), *Callicarpa americana, Calycanthus floridus, Clethra alnifolia, Diervilla rosea, Hydrangea arborescens, Hydrangea arborescens sterilis, Jasminum nudiflorum, Nandina japonica* (B), *Spiræa vanhouttei, Viburnum suspensum* (B).

Shrubs to 8 Feet.—*Abelia grandiflora* (B), *Aucuba japonica* (B), *Escallonia montevidensis* (B), *Evonymus alatus, Evonymus japonicus, Forsythia suspensa, Forsythia viridissima, Gardenia jasminoides* (B), *Ilex glabra* (B), *Ilex verticillata, Ligustrum sinense, Myrica carolinensis* (H), *Viburnum tinus* (B).

Shrubs to 10 Feet.—*Æsculus parviflora, Acanthopanax pentaphyllum, Callistemon lanceolatus, Ceanothus thyrsiflorus, Hydrangea paniculata, Ligustrum japonicum* (B), *Myrtus communis* (B), *Philadelphus coronarius, Philadelphus inodorus, Physocarpus opulifolius, Pittosporum tobira* (B), *Spartium junceum.*

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Shrubs to 15 Feet.—*Hamamelis virginiana, Hydrangea paniculata grandiflora, Hydrangea quercifolia, Ilex vomitoria* (B), *Ligustrum lucidum* (B), *Magnolia glauca* (B), *Magnolia stellata, Nerium oleander* (B), *Osmanthus aquifolium* (B), *Osmanthus fragrans, Photinia serrulata* (B), *Punica granatum* (B), *Pyracantha coccinea lalandi* (H), *Syringa vulgaris.*

Shrubs or Small Trees to 20 Feet.—*Camellia japonica* (B), *Caragana arborescens, Ilex crenata* (B), *Jasminum humile, Melaleuca decussata, Pieris japonica* (B), *Pittosporum phillyrœoides* (B), *Thea sinensis* (B).

Shrubs or Small Trees to 25 Feet.—*Buxus sempervirens* (B), *Ilex aquifolium* (B), *Ligustrum ovalifolium* (H), *Pittosporum undulatum* (B), *Prunus ilicifolia* (B), *Prunus caroliniana* (B).

Large Trees.—Willow oak, beefwood, live oak (B), laurel oak (B), silk oak, magnolia (B), camphor (B), rubber (B), palms of various kinds (P).

Plants for Region 32

Shrubs to 4 Feet.—*Callicarpa purpurea, Cistus ladaniferus* (B), *Cotoneaster simonsi, Evonymus radicans* (B), *Pieris floribunda* (B).

Shrubs to 6 Feet.—*Callicarpa americana, Nandina japonica* (B), *Viburnum suspensum* (B).

Shrubs to 8 Feet.—*Aucuba japonica* (B), *Escallonia montevidensis* (B), *Evonymus japonicus* (B), *Gardenia jasminoides* (B), *Ilex glabra* (B).

Shrubs to 10 Feet.—*Acanthopanax pentaphyllum, Callistemon lanceolatus, Ligustrum japonicum* (B), *Myrtus communis* (B), *Photinia serrulata* (B), *Pittosporum tobira* (B), *Viburnum tinus* (B).

Shrubs to 15 Feet.—*Ilex vomitoria* (B), *Ligustrum lucidum* (B), *Nerium oleander* (B), *Osmanthus fragrans* (B).

Shrubs or Small Trees to 20 Feet.—*Ilex crenata* (B), *Jasminum humile, Melaleuca decussata, Pieris japonica* (B), *Pittosporum phillyrœoides* (B), *Thea sinensis* (B).

Shrubs or Small Trees to 25 Feet.—*Ilex aquifolium* (B), *Pittosporum undulatum* (B), *Prunus ilicifolia* (B), *Prunus caroliniana* (B).

Large Trees.—Live oak (B), silk oak, camphor (B), rubber (B), evergreen magnolia (B), beefwood, laurel oak (B), Jacaranda (H), holly (B), Parkinsonia, many palms including the royal palm (P).

Grasses for Lawns

General—*Soil.*—Lawns require a deep, well-drained, thoroughly enriched, moisture-holding, weed-free soil whose bottom layers are compacted after plowing, but whose surface is finely pulverized for 2 inches.

Fertilizers.—Preparatory fertilization should be done with green-manure crops or carefully composted stable manure. Substitutes are ground bone, fish scrap, cottonseed meal, or similar fertilizers at the rate of 500 to 2,000 pounds per acre.

Propagation.—Kentucky blue grass, redtop, and white clover are started from seed; carpet grass, St. Augustine grass, mesquite grass, centipede grass, and Bahia are propagated from rooted runners; and Bermuda grass and creeping bent may be started in either way. Lawns started in the fall have less competition with weeds during the critical period. Sow the seed three months before freezing weather, or set the roots just before the moist season begins, so that they will become established before winter and the following hot, dry weather.

Cutting.—Cut the grass as soon as the lawn mower will take hold. A good lawn will result on a good soil liberally top-dressed, if the grass is cut frequently and regularly and is well supplied with water. Grass clippings should not be removed. Cut often enough to allow the clippings to disappear about the roots in a day or two.

Watering.—Make frequent, heavy waterings when necessary. Light daily waterings are bad, though copious daily waterings may be necessary on leachy soils in dry climates.

Lawn problem.—Only a few grasses form a close turf suitable for lawns. The lawn problem, therefore, is largely confined to making conditions congenial to lawn grasses, rather than to selecting grasses suited to conditions in different parts of the country, although some selection is also possible. Outstanding characteristics of the grass determine the method of handling.

Kentucky Blue Grass.—Requires plenty of moisture and thrives in cool and even cold weather that is not actually freezing. Hence a clay soil or a soil having a clay subsoil is considered best, although a lighter soil that has a permanent water table 2 to 4 feet below the surface is almost equally good. Lime also is needed, if the soil has any inclination to acidity. As Kentucky blue grass takes two or three years to spread out enough to make a good turf, it should be sown with a grass that will give a quick temporary effect. It does well in moderate shade.

Redtop.—Most successful on gravelly soils. Seems to thrive where Kentucky blue grass fails in regions where climatic conditions are favorable to blue grass. Makes a lawn the first year. For these reasons it is usually sown with Kentucky blue grass. Use either equal parts by weight or 1 part redtop and 3 parts of blue grass, and apply 100 pounds per acre of either mixture.

Creeping Bent.—Most used and best of the many species of bent grasses. Adapted to warmer and drier conditions than Kentucky blue grass, though thriving throughout the blue-grass region. Especially recommended for golf greens. As it spreads rapidly by stolons, the practice of growing selected strains in nursery rows and planting the stolons is being encouraged. These stolons are dug two months or more before freezing weather, chopped into 1 or 2 inch lengths, sown thinly over well-prepared soil, so that pieces will be about 2 inches apart, and covered promptly with a layer of rich, friable soil, then well watered. Seed of a mixture of bent grasses, including creeping bent, may also be used. This mixture is sold as German bent.

Red Fescue.—Probably the most generally satisfactory shade grass, next to Kentucky blue grass, in the cooler regions. Sow at the rate of 50 pounds per acre.

White Clover.—Often useful as a nurse crop for Kentucky blue grass, making a temporary lawn for a year or two on well-limed or naturally sweet soils. Sow only in spring in the North, or in October on Bermuda-grass lawns in the South, at the rate of 10 pounds per acre.

Bermuda Grass.—Most generally used lawn grass south of the natural Kentucky blue-grass region, except where special efforts are made to meet blue-grass requirements. Essentially a warm-season grass, turning brown with the advent of cool nights even before frost, thriving in hot weather, and standing much drought. Spreads by stolons and becomes a somewhat persistent weed in cultivated ground. May be started in the spring, similarly to the way creeping bent is started, with stolons collected from fields or plants. Set 1 to 2 feet apart each way,

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and keep cultivated for a few weeks. Seed may be sown at the rate of 20 pounds per acre. Since Bermuda-grass lawns are brown in winter it is a common practice to disk them in October, to sow perennial rye grass or white clover, and roll, in order to have a green winter lawn. The Bermuda grass will establish itself the next season.

Carpet Grass.—More attractive than Bermuda grass, adapted only to warmer regions, is less persistent, and grows in shade as well as full sunlight. It is set out in the same way as Bermuda grass.

St. Augustine Grass.—Has a broader leaf than carpet grass and is useful on the light lands near the coast south of Charleston, S. C. Planted in the same way as Bermuda grass and carpet grass.

Bahia.—Promising new grass with broad, dark leaves and low habit of growth that is attractive. Established like carpet grass.

Creeping Lippia (Lippia canescens).—Creeping plant used as a substitute for grass in warm, dry regions. Has a small, grayish foliage and in midsummer small, purplish flowers. Will stand much trampling, grows with little water, and requires no cutting except restraining around the edges of the planted area. The plants are set out 1 to 2 feet apart at the beginning of the rainy season.

Grasses for Different Regions.—Grasses suited to the different sections of the country are given by regions as shown by the map.

Region 1.—With watering, Kentucky blue grass, redtop, creeping and other bents. For shade, Kentucky blue grass, red fescue. With little or no watering, Bermuda grass and *Lippia canescens.*

Region 2.—With occasional watering, Kentucky blue grass, redtop, creeping bent, German bent, and native grasses. For shade, Kentucky blue grass and red fescue.

Region 3.—With irrigation, Kentucky blue grass, redtop, creeping bent, and native grasses like mesquite. For shade, Kentucky blue grass and red fescue. With little watering, Bermuda grass and *Lippia canescens.*

Region 4.—With irrigation, mesquite, curly mesquite, and other native grasses, Kentucky blue grass, redtop, and creeping bent. For shade, Kentucky blue grass and red fescue. With little or no irrigation, mesquite with Bermuda grass at the lower altitudes in the West.

Region 5.—With copious watering, Kentucky blue grass, redtop, mesquite grass, creeping and other bents. For shade, Kentucky blue grass and red fescue. With less watering, Bermuda grass, and with little watering, *Lippia canescens.*

Region 6.—With watering, Kentucky blue grass, redtop, creeping and other bents. For shade, Kentucky blue grass and red fescue.

Region 7.—With frequent watering, Kentucky blue grass, redtop, creeping and other bents, and mesquite grass. For shade, Kentucky blue grass and red fescue.

Region 8.—With much watering, Kentucky blue grass, redtop, creeping bent, and other bents. For shade, Kentucky blue grass, red fescue.

Region 9.—With copious watering, Kentucky blue grass, creeping bent, redtop, mesquite grass. For shade, Kentucky blue grass, red fescue.

Region 10.—With very heavy watering, Kentucky blue grass, redtop, creeping bent. For shade, Kentucky blue grass, red fescue. With less watering, Bermuda grass and *Lippia canescens.*

Region 11.—With copious watering, Kentucy blue grass, redtop, creeping bent. For shade, Kentucky blue grass, red fescue.

Region 12.—With frequent watering, Kentucky blue grass, redtop, creeping bent. For shade, Kentucky blue grass, red fescue.

Region 13.—With frequent watering, Kentucky blue grass, redtop, creeping bent. For shade, Kentucky blue grass, red fescue.

Region 14.—With frequent watering, Kentucky blue grass, creeping bent, redtop. For shade, Kentucky blue grass, red fescue.

Region 15.—With abundant watering, Kentucky blue grass, redtop, mesquite, creeping bent. For shade, Kentucky blue grass, red fescue.

Region 16.—With abundant watering, Kentucky blue grass, redtop, creeping bent. For shade, Kentucky blue grass and red fescue. With somewhat less water, mesquite, Buffalo grass, Bermuda grass.

Region 17.—With very copious watering, Kentucky blue grass, creeping bent, redtop. For shade, Kentucky blue grass, red fescue. With somewhat less water, Bermuda grass, centipede grass, St. Augustine grass. For shade, carpet grass.

Region 18.—With abundant watering, Kentucky blue grass, redtop, mesquite grass, creeping bent, German bent. For shade, Kentucky blue grass and red fescue.

Region 19.—With abundant water, Kentucky blue grass, mesquite grass, creeping bent, redtop. For shade, Kentucky blue grass and red fescue.

Region 20.—With abundant water, Kentucky blue grass, mesquite grass, creeping bent, redtop. For shade, Kentucky blue grass, red fescue. With somewhat less water, Bermuda grass, carpet grass, and other native grasses. For shade, carpet grass.

Region 21.—With water for frequent droughts use Kentucky blue grass, redtop, mesquite and other native grasses, and creeping bent. For shade, Kentucky blue grass and red fescue.

Region 22.—With water for droughts use Kentucky blue grass, mesquite, creeping bent, redtop. For shade, Kentucky blue grass, red fescue.

Region 23.—With water for occasional droughts, Kentucky blue grass, redtop, creeping bent. For shade, Kentucky blue grass, red fescue.

Region 24.—Kentucky blue grass, redtop, creeping bent. For shade, Kentucky blue grass, red fescue.

Region 25.—Kentucky blue grass, creeping bent, redtop. For shade, Kentucky blue grass, red fescue.

Region 26.—Kentucky blue grass, redtop, creeping bent. For shade, Kentucky blue grass, red fescue.

Region 27.—Kentucky blue grass, redtop, creeping bent. For shade, Kentucky blue grass, red fescue.

Region 28.—Creeping bent, redtop. For shade, Kentucky blue grass, red fescue.

Region 29.—Bermuda grass, with perennial rye or white clover added each fall to make a green winter lawn, carpet grass, creeping bent. For shade, Kentucky blue grass, carpet grass, red fescue.

Region 30.—Carpet grass, St. Augustine grass, Bermuda grass, with perennial rye or white clover for winter, centipede grass, Bahia, *Lippia canescens* in dry situations. For shade, carpet grass.

Region 31.—Carpet grass, St. Augustine grass, Bermuda grass, centipede grass, Bahia, *Lippia canescens* for dry situations. For shade, carpet grass.

Region 32.—St. Augustine grass, carpet grass, Bermuda grass, centipede grass, Bahia. For shade, carpet grass.

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PROPAGATION

General

Varieties of tree fruits to be kept true to type or name must be budded or grafted. Seedlings are nearly always worthless, so should not be used as orchard trees. Budding is done by taking a bud of the variety desired and placing it in a particular way described under budding in a seedling or rooted cutting called a "stock." Budding and grafting are both done on the limbs of trees. This is called top-working, and the limbs are then called "stocks." Grafting is also done on whole seedling roots or piece seedling or other roots. This is called root grafting, and the draft is called the "cion" and the root the "stock."

Seed

Number of fruit seeds per pound

Fruit	Number of seeds	Fruit	Number of seeds
Apple	12,000	Pear	15,000
Cherry	1,000	Plum	600
Peach	200	Quince	15,000

Storage—*Stratification.*—Hard-shelled seeds, like black walnuts, butternuts, hazelnuts, hickory nuts, and peach, plum, and apricot pits for planting may be kept dry but will make a better and more uniform stand if stratified over winter. This may be done in a box or coldframe, or in the open if the place is well drained. If a box is used, start with a layer of earth 2 or 3 inches thick, then a layer of nuts or pits of the same thickness, then alternate layers of earth and nuts, finishing with earth. Do not protect from freezing, since this helps to crack the hard pits. In March or April the shells will be split and the kernels growing. Plant in nursery rows 4 feet apart, spacing the seeds about 8 inches apart in the row. Apple, pear, and quince seeds may be kept dry or be mixed with moist earth and kept in a cool, dry place until planting time in the spring.

Seed Bed.—For small seeds, like those of the apple, pear, and quince, prepare a seed bed 12 to 15 inches deep, and add manure or fertilizer to make it rich. Plant the seeds an inch or two apart in rows a foot apart, and give the seedlings good care. If they grow rapidly the first year they may be dug in the fall for root grafting during the winter or spring, or be planted 8 inches apart in nursery rows 6 feet apart for budding later. If the seedlings are too small, they must be left in the seed bed for another year.

Graftage

General.—This includes both budding and grafting.

Budding.—Budding is done on 1-year old or younger seedlings called stocks, or on small limbs of trees, usually young trees.

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Shield.—Shield budding is the common method used in propagating deciduous and citrus trees. Buds are used from new growing twigs known as bud sticks. As soon as they are cut from the tree, trim off the leaves, except half an inch of each leaf stem, which facilitates handling the bud. Cut the bud sticks from a tree of the variety to be propagated. In the limb or seedling to be budded make a cross cut from a quarter to half an inch long and a downward slit an inch or more long in the shape of a capital T. In cutting a bud from the bud stick begin a quarter of an inch below the bud and slice the bark to a quarter of an inch above. Take as little wood as possible with the bud. If more than a very thin slice of wood comes off with the bud it should be taken out. Slip the bud into the T-shaped cut on the stock, and wrap carefully with raffia or soft cord to hold the bud in place. In 10 days cut the wrapping on the side opposite the bud or it will strangle the limb at the point of budding. If budding is done in the fall the buds remain dormant until the next spring. Before the buds start growth in the spring cut the stock off just above the bud so that all new growth will be made from the bud. If budding is done in June, cut off about half of the stock above the point of budding at the time of budding, and when the bud starts growth cut off the rest just above the bud.

Patch.—The patch bud is used particularly in budding the Persian (English) walnut, black walnut, butternut, pecan, and hickory. This kind of budding is done by cutting a patch of bark about an inch long and three-quarters of an inch wide that has a dormant bud in the center, and placing it where a piece of bark of equal size has been taken from the limb to be budded. This must be done when the bark slips. In the absence of a special patch-budding tool, tie two knives together with a block of wood between them, so that the blades will be about an inch apart. Cut across the bark above and below the bud with these blades, then cut up and down with one blade, making the patch the proper width. If the bark is not of the same thickness on both stock and bud, trim the rough bark from around the place on the stock where the bud is to be set, so it will be about as thick as the bark of the bud. Cut out a patch of trimmed bark and set in the bud patch. Tie tightly with stout string, and cover all but the bud with grafting wax, or wrap tightly with waxed cloth. Air and moisture must be kept out.

The buds for spring budding are on 1-year old shoots. Cut these bud shoots in late fall, winter, or early spring, and store in damp sand or moss in a cold place, or in cold storage at about 35° F. The buds will remain dormant, if buried a foot or two deep on the north side of a building. A day or two before budding is to be done place the lower end of the bud shoots in water, in a warm room, and the bark will peel readily. The bark on nut trees usually slips for a month or more after the buds begin to swell in the spring, and then again in the fall. In fall budding take the buds from the new growth. The buds are in the axils of the leaves. Cut off the leaves and keep the bud sticks moist, but use as soon as cut from the tree. The buds used in fall budding remain dormant until the next spring. When the buds start growth in the spring cut off the limbs upon which they are set just above the buds. When the new growth is a foot or more long tie it to a stake or other support so the wind will not blow it out.

Chip.—Chip budding is done in early spring in propagating or top-grafting nut and persimmon trees. It is done on small limbs, preferably only 1 year old. At

a smooth place on the stock make a downward sloping cut through the bark and into the wood. This cut should be about an inch long and nearly one-quarter through the stock. Make another cut, starting into the bark and wood just above the lower end of the first cut, yet meeting the lower end of the first cut. Cut a chip of bark and wood with a bud in the center from a dormant bud stick the same size as the stock, and place this where the chip was cut out of the stock. The cambium bark of the bud chip must be placed in contact, on one side at least, with the cambium bark of the stock. Either wrap the chip bud with grafting cloth or tie tightly with cotton twine. Then cover all cut surfaces with grafting wax. As soon as the bud starts to grow rub off all other buds on the stock every few days, so as to force all growth into the chip bud. After the bud has grown into a shoot 5 or 6 inches long tie it to the stock above (from which all buds must be kept off) or cut the stock off just above the new shoot, and use a stake or other support to which the new shoot may be tied.

Grafting—*General.*—Grafting, as well as budding, is done for the purpose of continuing particular kinds or varieties of tree fruits, other trees, and some ornamentals. The roots or limbs to be grafted are called "stocks," and the pieces of twigs set into the stocks are called "cions" or "grafts." Cions are usually about 3 inches long and have three or four buds. Grafting is done in the spring when stocks and cions are dormant, preferably just before the growth starts, except that plums and cherries should be grafted very early in the spring. Budding is done mostly in the late summer or early fall, when the bark of the stock slips or peels. On peach seedlings budding is often done in June, and these trees are called "June buds." Peaches are usually budded rather than grafted, but peach roots are sometimes grafted to plum cions when plums on peach roots are desired.

Whip or tongue.—This method is used in grafting small twigs or limbs up to one-half or three-quarters of an inch in diameter. It is usually employed in top-working young trees or small limbs on older trees and in making grafts. Prepare the lower end of the cion by making a long slanting cut clear across the end. Then make a backward cut on the long side between the pith and the bark. This forms the tongue. Prepare the top end of the stock in exactly the same manner. Place the cut surfaces of the prepared ends together, and the tongue of each will fit into the backward cut of the other. Push together tightly, having the cambium or inner bark of both in contact along one side. Tie with a string or raffia, and in top-grafting cover all cut surfaces with grafting wax. This method is used for all kinds of fruit and nut trees.

Cleft.—Cleft grafting is used on fruit and nut trees for top-grafting limbs too large for whip grafting, even up to 4 inches in diameter. In grafting limbs about 2 inches or less in diameter make the cleft or split across the center, and put in two cions. Larger limbs may have two clefts made parallel halfway between the pith and each side, and the two grafts placed in each. To prepare a limb for cleft grafting, saw it off at the desired place, leaving the stub short rather than long. Make this slightly sloping to shed water. Trim off the saw marks with a sharp knife. With a grafting chisel or heavy knife, make the cleft and drive a wedge

in the center to hold it open while fitting the cions. Trim the lower end of the cion to a long wedge shape with one side a little thicker than the other, and with a bud at the upper end of the thicker side. Shove the wedge end firmly, thick side out, into the cleft so placed that the cambium or inner layers of bark of cion and stock are in contact. Place two cions in each cleft. Remove the wedge so that the cleft will close up against the cions. Bind a strong cord around the stub to hold the cions in place. Fill up the cleft and cover all cut surfaces with grafting wax.

Slip-bark.—This method is used, when the bark slips, for grafting large limbs of nut trees, but may also be used for fruit trees. Saw off the limb at the place to be grafted. Trim the cut end of the stub limb smooth with a sharp knife. Cut a slit about 2 inches long through the bark down one side, beginning at the cut end of the stub limb. If the bark is thick and rough, trim off all rough parts, so it will be flexible. The cion should be 4 to 6 inches long, with 3 or 4 buds, and completely dormant. Make a long, smooth, sloping cut (1½ to 2 inches) clear across the butt end of the cion. Slip the cion into the slit cut in the bark of the stock and push it down the whole length of the sloping cut of the cion. If the limb is more than 2 inches across, put in two cions opposite each other. Tie tightly with a stout string and cover all cut places with grafting wax. Slip a paper bag over the grafted limb and tie securely. When the cion begins growing, take off the paper bag and cut the string wraps. Rub off all buds that start growing on the stub limb.

Bridge.—This method of grafting is used to save fruit trees that have had the bark injured by mice, rabbits, or in any other manner. The injury is usually on the trunk just above or below the surface of the ground, but the roots also are sometimes injured. Trim off all ragged edges back to the live bark. Use 1-year-old twigs for cions. Cut them about 4 inches longer than the distance across the injured bark. Use cions one-fourth to three-eighths inch in diameter and as long as necessary, up to 3 feet. Cut a slice of bark and wood about 2 inches long from the same side of each end of the cion, extending nearly halfway through it, and leave this cut portion flat. Shave the dark outer bark from each edge of the flattened cion ends. Hold the cion in position with trimmed ends where they are to be placed, and mark their positions on the bark of the tree. Cut out the pieces of bark so marked, set in the cion, and drive a brad or two in each end to hold the cion in position. Place cions 2 or 3 inches apart around the trunk. Cover the ends of the cions and the edges of the trimmed bark with grafting wax, and mound up with earth around the trunk. The lower end of the cions may need to be placed in the bark of the roots. Another way to fasten the cions in position is to cut them 2 or 3 inches longer than across the injury and make a sloping cut 2 inches long clear across each end. Cut slits into the bark above and below the injury, and force the trimmed ends of the cions into these slits. Wax the ends of the cions and all cut surfaces, and mound up with earth.

If young trees are injured and there is not enough root system left to bridge graft into successfully, the following plan is recommended: Plant two or three 1 or 2 year old seedling trees close to the injured tree. Trim a very thin shaving of bark off each seedling tree and the injured tree where they touch each other; drive in two or more brads to hold seedlings in place

and cover all cut surfaces with grafting wax. Keep all buds rubbed off the seedling trees below the point of contact with the injured tree, but let the tops above grow until the points of grafting have grown together. Then cut off the seedling tops, and the injured tree will be nourished by the seedling roots.

Materials—*Stocks.*

Stocks for grafting fruit trees

Kind of tree to propagate	Recommended stocks to use
Almond	Peach, hardshell almond, or plum.
Apple	Apple, crab, or wild crab. French crab stocks are the common apple seedlings grown in France. Paradise and Doucin stocks are dwarf.
Apricot	Apricot and peach in severe climate. Marianna plum.
Cherry	Mazzard cherry for sweet varieties and mahaleb for sour varieties. Mahaleb stock has a dwarfing effect.
Nectarine	Peach. Plum is used in heavy soil.
Peach	Do.
Pear	Common pear or oriental pear.
Persimmon	Native persimmon for both Japanese and native.
Plum	Plum (different species). Peach on light, sandy soil.
Quince	Quince or apple.

Grafting wax.—Use 4 parts of rosin, 2 parts of beeswax, and 1 part of tallow or linseed oil. Melt the rosin, and let it simmer two or three minutes. Cut the beeswax into thin slices, put it into the rosin, and let it simmer for about two minutes. Add the tallow or linseed oil and stir and cook a few minutes, then pour into cold water. Grease the hands with tallow, work and pull the wax as molasses candy is pulled, until it becomes light yellow, smooth, and elastic like rubber gum. Mold into balls or sticks, and wrap in waxed or oiled paper.

Liquid grafting wax.—Cook together for about two minutes 1 pound of rosin and 1 ounce of tallow or linseed oil. Remove from the fire and pour in slowly while stirring, 8 ounces of grain alcohol if it can be procured. Denatured alcohol has been used with good success, but it has also been reported as causing injury to grafts. When it is cool, pour into wide-mouthed bottles and cork securely. Apply with a brush or small paddle. If this is too thick to spread well, reheat, remove from the fire, and stir in a little more alcohol. If it is too thin to stick well, put in more rosin, cook, and stir for a few minutes.

Paraffin wax.—This is the ordinary paraffin wax or parawax used to cover jelly when it is put in glasses. Melt the parawax, and heat it just enough to make it spread thinly. If spread too thickly it will crack. This is especially useful in nut-tree grafting, the entire graft and all cut surfaces being covered. A small brush that has fine bristles should be used.

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Cloth.—Lay old cotton cloth on a board or table, and spread melted grafting wax on one side. Let it dry, and tear into strips when ready to use.

Cord.—Dip knitting cotton into melted grafting wax, drain off the surplus wax, and the cord is ready to be used.

Miscellaneous—*Double-worked nursery trees.*—Some nurserymen are offering double-worked Grimes Golden apple trees. Since the trunk of Grimes Golden is subject to collar blight and is usually short lived, some variety with a healthy trunk, like Northern Spy or Tolman Sweet, is first budded or grafted into the seedling roots and grown for one year. Then Grimes Golden is either grafted or budded into the top. The double-worked tree then has a Grimes Golden top, Northern Spy body, and a seedling root.

Dwarf pear trees are also double-worked on quince roots. The Angiers pear is about the only one that makes a good union with quince roots, so it is grafted on quince roots and grown for one year. Then some other pear variety is budded into the Angiers portion low down on the trunk.

OPERATIONS

Planting

Systems—*Square.*—To lay out an orchard on the square system on level or slightly rolling land, set a row of tall stakes, 4 or more feet high, as far apart in the rows as the trees are to stand along one side of the field. Locate this row at least half as far from the field boundary as the rows are to be apart. Also have the end trees an equal distance from the end boundaries. Set another row of stakes exactly opposite these, along the other side of the field, and a row through the middle in line with the outside stakes, so that each set of three stakes marks a tree row across the field. Plow a furrow to mark out each row as indicated by each set of three stakes.

Move the stakes and set at proper distances in a row at each end and across the middle of the field so that each set of three stakes indicates a row lengthwise. Plow a furrow to mark out each row. Each furrow intersection is a position for a tree. Dig out enough earth at each furrow intersection so as to plant the tree an inch or two deeper than it stood in the nursery.

Another way to lay out an orchard is to set long stakes at proper distances apart to mark the rows along both sides and across both ends of the field. Set a row of stakes lengthwise and another crosswise through the center of the field so that all rows are indicated by sets of three stakes. Beginning at one corner one person sights lengthwise, another sights crosswise, and a third person sets short stakes where told to do so by the sighters to mark tree positions. The whole field is staked in this manner.

Another simple method requires no long stakes, but does need a long wire with markers on it the distance apart of the rows. Set a row of stakes across each side or end of the field at the proper distance apart for the rows. Stretch the wire between opposite stakes and set a short stake at each marker. Repeat until the entire field is staked.

Quincunx.—The quincunx system of planting, as the definition of the word implies, is an arrangement consisting of five trees. This is really the square system with a filler tree in the center of each set of four permanent trees. When the center filler tree is finally taken out the square system of permanent trees is left.

Hexagonal.—In this system the trees in adjoining rows "break joints" with one another; that is, the trees in the second row, instead of being opposite those in the first row, are opposite the center point between any two trees of the first row. The trees of the third row are opposite those of the first row. Thus all the trees are equally distant from one another and are in triangles as well as being in a hexagonal or six-sided position with one tree in the center. Thus, each set of seven trees forms a hexagonal group with one in the center and one at each corner of the six-sided figure surrounding it. At 40 feet apart this system accommodates four more trees to the acre than the square system, but the driving space between the rows is narrower, and thus cultivating and spraying are not so easily done.

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Contour.—When rows are laid out on irregular slopes where the contour is to be followed, a level or some other type of instrument that can be used for leveling is practically essential. This system is more difficult than laying out an orchard on level ground, and the rows and trees are not always the same distance apart. Begin on the highest slope, and run the row at about the same elevation around the slope, the wavy line being the contour. Locate trees in this row at the required distance apart. Run the second row as near the proper distance as possible from the first one, keeping it at about a constant elevation, and space the trees in relation to trees in the first row. Continue in like manner for the other rows. They will be farther apart on gentle slopes and nearer together on sharper slopes. Some rows may run out entirely on steep slopes. Cultivation is done along the rows, rather than crosswise, and in time, as the earth just above each row is worked toward it, the whole field takes on the appearance of being terraced. Uneven orchard ground, that washes badly, should be planted in contours.

Comparison of systems.—The square system has the advantage over other systems in that the straight spaces between rows make cultivating and spraying easier. More trees per acre are used in the hexagonal, quincunx, and other systems, and hence, the open driving spaces are more limited. Most orchards are planted on the square system.

Number of trees required for a square acre of trees planted at different distances

Distance apart	Number of trees		Distance apart	Number of trees	
	Square system	Hexagonal system		Square system	Hexagonal system
25 feet	70	79	35 feet	35	41
28 feet	56	64	36 feet	34	39
30 feet	48	56	40 feet	27	31
33 feet	40	46	45 feet	22	25

The number of trees required for an acre is determined by multiplying the distance between rows by the distance between the trees in the row, and dividing 43,560 (the number of square feet in an acre) by the product. The numbers given in the tables are the nearest full unit in the computation. The exact number which can be actually planted on a given area at a specified distance apart will vary slightly in different instances, depending on the shape of the area to be planted.

Distance between rows for an acre planted according to the hexagonal system with apple trees at specified distances in the row

Distance between trees in a row	Distance between rows		Distance between trees in a row	Distance between rows	
	Ft.	*in.*		*Ft.*	*in.*
25 feet	22	1	35 feet	30	4
28 feet	24	2	36 feet	31	2
30 feet	26	0	40 feet	34	7
33 feet	28	7	45 feet	38	11

Square corner or right angle.—If the field is irregular in outline and square corners are desired, proceed as follows: In one corner drive stake No. 1 where the corner tree will stand. Measure off 12 feet along the line of the first row, namely, to the east or west, and drive stake No. 2. Measure off 9 feet from stake No. 1, north or south, and set stake No. 3, which also must measure exactly 15 feet from stake No. 2. If these three stakes are exactly 9, 12, and 15 feet apart they form a square corner or right angle.

Planting board.—A planting board is a convenience in the setting of the trees. It should be 3 or 4 inches wide, and 3 or 4 feet long. Saw a deep notch in the center and one at each end. Place it with center notch around a tree stake, and set a stake in each end notch. Remove the board and tree stake, and dig the hole. Replace the board, hold the tree in the center notch, and shovel in and trample down the earth. No sighting is necessary, and the trees are in straight rows.

Planting Table.

Number of plants or trees per acre planted at different distances apart

Distance apart (feet)	Plants per acre	Distance apart (feet)	Plants per acre	Distance apart (feet)	Plants per acre
½ by 1	87,120	6 by 8	907	20 by 40	54
½ by 1½	58,080	6 by 9	806	24 by 24	75
½ by 2	43,560	6 by 10	726	24 by 30	60
½ by 2½	34,848	8 by 8	680	30 by 30	48
1 by 1	43,560	8 by 10	544	33 by 33	40
1 by 1½	29,040	8 by 12	433	36 by 36	33
1 by 2	21,780	10 by 10	435	38 by 38	30
1 by 2½	17,424	10 by 12	363	40 by 40	27
1 by 3	14,520	12 by 12	302	44 by 44	22
1½ by 3	9,680	12 by 14	259	48 by 48	18
2 by 2	8,640	14 by 16	194	50 by 50	17
2 by 3	5,760	15 by 15	193	55 by 55	14
3 by 4	3,630	16 by 16	170	60 by 60	12
3 by 5	2,904	16 by 18	151	65 by 65	10
3 by 6	2,420	16 by 20	136	70 by 70	9
4 by 4	2,722	16½ by 16½	160	75 by 75	8
4 by 6	1,850	16½ by 33	80	80 by 80	7
4 by 8	1,361	18 by 18	134	85 by 85	6
5 by 5	1,742	20 by 20	108	90 by 90	5
5 by 8	1,089	20 by 30	72	100 by 100	4

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Fruit Trees—*Heeling in nursery trees.*—As soon as nursery trees are received, open the package and either plant them at once or heel them in. To heel in trees, dig a trench a foot or more deep, banking the earth along one side. Place a row of trees close together with roots in the trench and trunks on the bank of earth. Dig out earth to widen the trench, and throw this earth over the roots and lower half of the trunks of the trees in the trench. Place another row of trees in the new trench, dig out more earth to cover the roots and make a new trench. Continue in this manner until the trees are all heeled in. Firm the earth so that no air pockets remain around the roots, and water if necessary. If this is done in the fall, point the tops toward the south so as to shade the uncovered portions of the trunks.

Pruning before planting.—Before planting nursery stock, cut off bruised parts and broken ends of roots, and cut back the sound roots to 4 to 6 inches in length.

Age to plant.—One-year-old budded trees of all kinds are preferable, but 2-year-old trees, except peach, are often used and usually give good results. "June buds" of peach are excellent. Root-grafted apple trees are more susceptible to crown gall than budded trees.

Digging holes for trees.—Dig a hole 2 feet or more across, and deep enough to set the tree an inch or two deeper than it stood in the nursery, or plow out a trench of the same depth. Hold the tree in position and shovel in the richest earth available, joggle the tree up and down to settle the earth around the roots, and trample the earth down as it is shoveled in until the hole is full. Scatter some loose soil around the tree after the last trampling has been done.

Blasting the holes.—Dynamite should be used only in very hard ground, rocky ground, or where hardpan is to be broken up. Bore a hole 2½ to 3 feet deep where the tree is to stand, load with half a cartridge of 20 per cent or other low-grade dynamite, and explode in the usual manner. Before planting a tree in a dynamited hole, shovel in some earth and trample down firmly, else the earth will settle away from the tree roots and they will dry out and die.

Tree wiring.—Fruit trees with heavy crops need props or other means of support to keep the limbs from breaking. Tree wiring is one of the best means of supporting branches. Place heavy screw eyes into the limbs rather high up and on the side toward the center of the tree. Fasten one end of a wire to each screw eye and the other end to an iron ring about 2 inches across the center of the tree. Each limb then helps to support the opposite limbs, and they can all sway together with the wind instead of being held rigidly in one place.

Transplanting Ornamentals — *Evergreens.* — Transplant evergreens only when the soil is warm and moist, so that root growth will start immediately and thus establish the plant at the earliest possible moment. In regions having cold winters these conditions usually exist for about a month in the fall, ending six weeks before freezing weather is expected, and a month in the spring, beginning six weeks after freezing weather is over. In regions that are almost frost-free it may be done any time during the moist season when the ground is not too wet. Move with a ball of earth about the roots in such a manner that contact of the roots with the soil is not broken. Plant in holes sufficiently large to permit the firm packing of moderately moist, rich soil around the ball to facilitate soil water keeping the ball moist and to permit the growth of new roots. The plant in its new location should be at the same depth it was before being

moved. A moist atmosphere that reduces the amount of evaporation from the foliage aids greatly by reducing the demands on the roots for water. Evaporation is often checked artifically by shading, protecting from wind, or spraying. Plant as long as possible before hot, dry weather begins. For several months after planting spray the tops frequently and keep the roots thoroughly moist.

Deciduous plants.—Transplant when the plants are dormant. In regions of cold winters, start six weeks before freezing weather begins and continue until six weeks after freezing weather is over. In mild-wintered regions begin whenever dormant plants can be obtained and the soil is in proper condition as to moisture. When plants have already budded, handle the same as evergreens. Holes should be dug sufficiently large so that the roots may be spread out in their natural position and still have 3 inches to spare beyond the ends. Earth that is neither too wet nor too dry should be firmly packed about them. Watering may be necessary in some regions. Set as long before the growing season as local conditions will permit, so that the root growth will start ahead of the top growth. Severe cold winters and cold combined with periods of drying winds are conditions against fall planting. A liberal watering followed by a heavy mulch and protection of the top from the wind and sun often makes possible fall transplanting where otherwise it would not succeed.

Pruning.—Remove all mutilated roots before planting. Give roots with bruised ends a clean cut. Plants moved with a good ball of earth need no pruning unless the ball is so small that many roots are cut. Remove at least half of the branches from those plants which have no earth about the roots and a portion of the roots which have been cut away in digging. Those dug with all their roots may need the removal of only a fourth of the top. Prune so that the natural shape of the top is kept.

Culture

Fruit—*Sod.*—The orchard is maintained in sod, the grass being mowed several times each season and removed from the orchard, or the grass crop may be pastured.

Sod mulch.—This is like sod culture, but the crop of grass is cut and left on the ground to form a mulch and to decay. Additional vegetable matter may be hauled in to increase the quantity of decaying mulch.

Mulch.—Enough straw, grass, coarse manure, and other vegetable matter is spread over the ground to smother out grass and weeds.

Clean.—The ground is given clean cultivation throughout the entire season.

Cover crop.—The ground is seeded to a crop such as clover, vetch, or cowpeas in late July, August, or early September, after the summer cultivation has ended. Rye may be sown much later. In some places weeds are allowed to grow in the fall for a cover crop. The following kinds of seeds and quantities per acre have given good results:

Crimson, red, alsike, and sweet clover, and alfalfa.	12 to 20 pounds.
Hairy vetch	40 pounds.
Rye	1 to 2 bushels.
Canada field peas	Do.
Cowpeas and soy beans	1 to 1½ bushels.
Dwarf Essex rape	8 to 10 pounds.
Winter oats	1 to 2 bushels.

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Combinations of some of these crops are desirable, such as rye and vetch, rye and Canada field peas (in the North), and clover and vetch. If two kinds are used, sow one-half of the above quantities of each per acre. Cowhorn turnips, 1 pound, and crimson clover, 10 pounds, make a good combination, wherever crimson clover endures the winter.

Clean and cover crop.—The ground is given clean cultivation until the cover-crop seed is sown. Not all cover crops live over winter, but those that do are plowed under in the spring, and clean cultivation is continued until time to sow cover-crop seed in the fall.

Shade crop.—In irrigated sections that have a hot summer climate, cover-crop seed is sown in the spring to shade the ground, or the winter crop may be allowed to grow during the entire summer for this purpose.

Intercrop.—An early-maturing crop, which does not need fall cultivation, is grown between the rows.

Care of Old Orchards—*Pruning.*—Cut out all dead and weak limbs, stubs, and the limbs that overcrowd. Make all cuts close to the trunk or supporting branch, so as not to leave a stub, even half an inch long. In taking off a large limb, saw about one-fourth through from the underside, so that the bark and wood will not tear down or splinter when the limb drops, as it would do if sawed from the upper side only. Then saw from the upper side to meet the lower cut. Do not take out all the crowding branches and twigs the first year, but leave some to cut out the second and third years.

Spraying.—(See 8.7.)

Cultivating and fertilizing.—It is usually best to cultivate all kinds of old trees and to use stable manure or commercial fertilizer. Apple and pear trees should have from 5 to 10 pounds of nitrate of soda or 4 to 8 pounds of sulphate of ammonia per tree spread broadcast two weeks before blossoming time. Peach, plum, and other trees, unless very large like the sweet cherry, should have only 3 to 6 pounds of these fertilizers spread at the time mentioned above. If the trees are left in sod, they should be fertilized, the above rates being used, or should have a heavy application of manure. The grass, when mowed, should be left on the ground to decay.

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PLANT DISEASES

GENERAL

Nature of Plant Diseases

Disease Defined.—In speaking of plant diseases one author has said, " Health is a state in which each organ performs its own function and acts in harmony with the others; and disease, in the broader sense of the word, consists of any departure from this state." Plant diseases belong to two distinct groups: (1) Parasitic and (2) nonparasitic. These two groups differ as to cause and therefore require different methods of control. **(1), (2), (3), (4), (9).**[1]

Parasitic Diseases.—Due to the attack of organisms which live on the higher plants and produce varying degrees of disease and disturbances, oftentimes finally resulting in the death of the plant or of some part of it. Most of the troubles in this group are caused by parasitic fungi or the related group, bacteria. In addition to these, there is an important group of infectious diseases, known as the virus troubles, with which no organisms have yet been definitely associated in a causal relation. Nemas, or microscopic animal parasites, and parasitic and epiphytic lichens belong in this group. Phytoptus and other mites, gall-producing and many puncturing insects cause disturbances which are essentially diseases. In Europe these are commonly classed as diseases and often studied by plant pathologists, but in this country it is customary to class all insect and mite injuries along with the other insect depredations on plants, and this whole group of pests is studied by entomologists. Insects often distribute bacteria, fungi, and infectious viruses, sometimes actually inoculating plants, and are thus instrumental in disseminating diseases which they do not directly produce.

Nonparasitic Diseases.—Sometimes are spoken of also as physiological or environmental diseases. They are the direct effect, sometimes cumulative, of unfavorable extremes of temperature and moisture, both in the soil and in the air, of light and of poisonous or unfavorable gases in the air and soil, of unbalanced chemical constituents of the soil, including actual poisons, and of unfavorable mechanical conditions of the soil, including nonaeration. Even unbalanced proportions of plant foods in the soil, which in proper relation might be beneficial, may produce disease. These environmental factors, which are capable of producing disease independently, also affect profoundly the severity of attack of parasitic diseases. Diseases of this group often produce definite symptoms and sometimes definite lesions by which they can be identified fairly accurately, usually more by external characters than by results of microscopic examination. They often are difficult to recognize in the laboratory, especially the milder cases, and always are easier to diagnose in the field. On the other hand, they often are difficult or impossible to diagnose in the absence of full knowledge of all the environmental factors, past and present.

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[1] Figures refer to bibliography at end of this section.

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Losses Resulting from Disease.—Some plant diseases cause serious reductions of yield, often completely destroying the crop in an individual field or orchard. Other diseases not only cut production, but may cause blemishing of the fruit, either making it unmarketable or throwing it into a low grade. Nailhead spot of tomatoes, apple scab, and potato scab are examples. Still others, as brown rot of peaches, potato late blight, and sweet-potato black rot, not only reduce the yield but so affect the harvested product as to cause decay in storage and transit. To wastage caused by this type of disease must be added destruction by still another group of diseases, which, although of little or no importance in the field, may be responsible for extensive losses during the marketing period. For example, Rhizopus rot of sweet potato, though not recognized as a field disease, may be very destructive after harvest.

Control.—Prevention plays an important part in control of parasitic diseases. At present spraying with fungicides constitutes an important method of attack, though use of proper cultural methods, disease-free seed, disinfection, eradication of host plants, and breeding of resistant sorts play important parts. Quarantine methods also have an important function in keeping out or preventing the spread of this type of disease. For these troubles the removal, eradication, or correction by various methods of the unfavorable physical factors constitute the principal methods of control. When there is any doubt as to the identity of a disease, representative material should be collected, prepared for mailing, and sent either to the State experiment station or to the Bureau of Plant Industry, United States Department of Agriculture, Washington, D. C.

ALKALOIDAL AND MEDICINAL PLANTS

Alkaloidal Plants

Tobacco (10)—*Black shank (Phytophthora nicotianæ).*—Found in Florida and Georgia in seed beds and fields. Primarily a stalk disease. Affects leaves and roots and also causes wilting and death.

Control: Avoid infested fields or seed beds. Transplant only healthy plants. Remove and destroy earliest infections. Promise of control by use of resistant strains.

Black root rot (Thielavia basicola).—General. Stunting of plants, blackened and deficient root system. Favored by cool soils. Occurs in seed beds and fields.

Control: Avoid infested soils or use resistant strains. Disinfect soil for seed beds.

Black rot (Aspergillus niger).—Found in fermenting tobacco. Causes decay and blackens the leaf.

Control: Do not pack tobacco too moist. Use bulk fermentation if necessary.

Black fire (Bacterium angulatum).—General. Angular leaf spot, usually without halo. Lesion light colored to dark brown or almost black.

Control: Seed-bed sanitation. Avoid transplanting diseased seedlings to field.

Blue mold (Peronospora hyoscyami).—Florida. Large, angular blotches on leaves and mildew on under surface.

Control: Seed-bed sanitation. Destroy infected plants and spray beds with Bordeaux mixture (2–2–50).

Broom rape (Orobanche ramosa).—Most prevalent in Kentucky. Damage usually small, if any. Yellowish, compact growth of parasite on roots usually extending above ground.

Control: Avoid infested soils. Rotate crops, using immune plants.

Brown root rot.—Cause not determined. Occurs particularly in Connecticut Valley. Causes plants to become stunted and roots brown, decayed, and deficient.

Control: Satisfactory control not fully worked out. Probably dependent on system of rotation used.

Damping off (Pythium debaryanum, Rhizoctonia solani, and other organisms).—Most prevalent in the North. Found in plant beds. Causes decay of stems, often entering the leaves, usually forming a slimy rot of plants in round areas.

Control: Soil sterilization. Thin sowing. Ventilate the beds.

Frenching.—General. Noninfectious. Cause not determined. A chlorotic appearance with increasing thickness of leaf in early stages. An abnormally high number of narrow leaves is most characteristic symptom.

Control: Avoid planting on areas known to yield high percentages of disease.

Frog-eye (Cercospora nicotianæ).—Southern States. Circular leaf spot with grayish-white center and dark-brown border. Generally on bottom leaves only.

Control: Not satisfactorily worked out.

Fusarium wilt (Fusarium oxysporum var. nicotianæ).—Southern States. Wilting of plant, vascular ring discolored. No ooze on pressure of stem.

Control: Avoid infested soils. Varieties differ in resistance to disease.

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Granville wilt (*Bacterium solanacearum*).—Southern States. Bacterial wilt. Wilting of plant, vascular ring darkened in color, and yielding ooze on pressure.
Control: Avoid infested soils. Rotate with nonhost plants.
Mosaic.—General. Infectious, but cause unknown. Irregular chlorotic areas in leaf. Leaves characteristically malformed. First evident in young leaves on plant. Infected plants usually stunted in growth.
Control: Seed-bed sanitation. Do not transplant from infected beds. Disease spread in field by handling of diseased and healthy plants.
Mustiness (*Oospora sp., Actinomyces sp.*).—Found in fermenting tobacco. Powdery, white growth on leaf surface, with a musty odor.
Control: Apparently most common on poorer qualities of leaf, in excessively humid surroundings.
Nonparasitic leaf spots.—Various causes. Symptoms varied. Important to distinguish from parasitic diseases.
Control: If any, dependent on nature of leaf spot.
Root knot (*Heterodera radicicola*).—Southern States. Stunting of plants. Roots swollen or gall-like.
Control: Avoid infested soil. Use immune crops in rotation. (31).
Sand drown.—Southern States and in Connecticut Valley. Caused by a deficiency of magnesium. A blanching or chlorosis of lower leaves, particularly on sandy soils. Do not confuse with potash starvation.
Control: Use fertilizers containing magnesium or use dolomitic limestone.
Shed burn or pole rot.—Cause not determined. In curing tobacco, darkening, or decay of leaf web causing harshness and loss of elasticity.
Control: Ventilate shed properly. Use artificial heat during excessively damp weather.
Sore shin or stem rot (*Rhizoctonia sp., Pythium sp., Sclerotinia sp., and other organisms*).—Found in the field. Decay of stalk starting near soil surface. Stalk brown or black, sometimes rotting or breaking off.
Control: Avoid transplanting diseased plants from seed beds and planting in poorly drained areas.
Stem rot.—Caused by various fungi. In curing tobacco, decay of midrib.
Control: Same as for shed burn.
Wildfire (*Bacterium tabacum*).—General. Round leaf spot with central lesion usually surrounded by distinct chlorosis or halo. Lesion whitish to reddish.
Control: Seed-bed sanitation. Avoid transplanting diseased seedlings to field.

Medicinal Plants

Ginseng (11)—*Alternaria blight and root rot* (*Alternaria panax*).—Dark-brown spots just above the surface of ground. These enlarge and become velvety in appearance. Later, large dead spots develop in leaves. At first these appear water-soaked, but gradually they become dry and papery in center, with a darker, yellow-brown border. Seed heads often affected, and as a result shell. Affected roots rot slowly. Firm rot with no odor.
Control: Sanitation. Spray with Bordeaux 3–3–50, with 2 pounds of lead arsenate to 50 gallons. Remove and destroy diseased tops. After tops die down, cover beds with straw and burn, or if this is impracticable, spray beds with copper-sulphate solution, 1 pound to 5 gallons of water.
Phytophthora mildew and root rot (*Phytophthora cactorum*).—Widespread. Leaflets at tops of affected plants droop at tip or base of petiole. Stems become hollow and

somewhat discolored. Leaf blades show spots of varying sizes, which with age develop a white center having a dark, water-soaked, green margin. Roots show semisoft rot.

Control: Rotate or sterilize soil. Spray with Bordeaux 3-3-50. To prevent disease passing from stem into roots, tops of plants showing wilting or drooping should be removed at crown. Remove and destroy affected roots and treat soil with formaldehyde, 1 part to 50 parts of water, or with copper sulphate, 1 pound to 5 gallons of water, these at the rate of 1 gallon per square foot. Tile-drain land before making up bed.

Thielavia root rot (*Thielavia basicola*).—Widespread. Grayish-black surface rot of roots. Root hairs and smaller rootlets sometimes are lacking, and taproot frequently becomes knoblike.

Control: Before planting sterilize infected beds. Maintain acid reaction of soil by use of acid phosphate 1,000 to 2,000 pounds per acre, and avoiding lime, ashes, or alkaline fertilizer.

Sclerotinia white rot (*Sclerotinia libertiana*).—General distribution. Affected stems lose green color and become hollow. Hard, black bodies develop within hollow stems and on outside of diseased roots.

Control: Good drainage and aeration. Diseased tops and roots should be removed and contaminated soil disinfected with copper sulphate or formaldehyde. See Phytophthora Root Rot.

Sclerotinia black rot (*Sclerotinia smilacena*).—Affects roots, making progress in winter only. Diseased plants fail to come up in spring, and if ground is dug, black mummified roots are found.

Control: Destroy diseased roots, and disinfect soil thoroughly with formaldehyde.

Damping off (*Pythium debaryanum, Phytophthora cactorum*).—Stems become soft and rot at surface of soil. Tops drop over.

Control: Before replanting an old bed, disinfect soil with formaldehyde or by steaming. Provide good drainage and aeration. Sprinkle clean sand on surface of bed to depth of one-fourth inch.

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CEREAL AND FORAGE CROPS

Cereals

Barley—*Bacterial blight* (*Bacterium translucens*).—South Carolina, Arkansas, Wisconsin, Minnesota, Iowa, Illinois, Montana, and Idaho. Translucent spots or stripes in leaves, becoming light brown. Bacterial exudate sometimes evident.

Control: No feasible control known or usually needed.

Covered smut (*Ustilago hordei*).—Generally distributed. Smutty heads. Smut galls tough, filled with mass of black smut spores. Floral organs not so completely destroyed as in loose smut.

Control: Sow clean seed or soak seed one hour in 0.3 per cent solution of Semesan, Uspulun, or Germisan, or 0.2 per cent Corona No. 620 (organic mercury compounds), or treat seed with formaldehyde.

Ergot (*Claviceps purpurea*).—Present in almost all barley States.

Control: See Rye.

Leaf rust (*Puccinia anomala*).—General. Small, circular, open pustules of yellow spores. Infection confined mostly to leaves. Young plants are sometimes killed by this rust.

Control: Breeding and selection for resistant strains.

Loose smut (*Ustilago nuda*).—General. Smutty heads. Floral parts almost completely destroyed. Loose mass of black smut spores.

Control: Sow clean seed or treat seed as for covered smut in 6-rowed barleys. Hot-water treatment recommended for 2-rowed barleys.

Net blotch (*Helminthosporium teres*).—Widespread. Localized, slightly "netted" brown blotches irregularly distributed on some or all leaves. Badly attacked leaves die and bleach. Head mature with some shrinkage when disease is very severe.

Control: Seed treatments are known to control this disease perfectly.

Powdery mildew (*Erysiphe graminis*).—Occurs generally.

Control: See Wheat.

Scald (*Rhynchosporium secalis*).—Central and Western States. Rather large, iregular, variously scattered blotches chiefly on blades and sheaths, which they kill. Blotches vary greatly in color from greenish blue to ashen gray; commonly chocolate brown at margins in advanced stages.

Control: Resistant strains or varieties. Disease of economic importance, chiefly in the West.

Scab (*Gibberella saubinetii.*)—Barley States east of the Great Basin.

Control: See Wheat.

Spot blotch (*Helminthosporium sativum*).—Widespread. Brown rot of underground parts, sometimes killing seedlings; brown blotches (without netting) in leaves; and brown tips or blighting of kernels.

Control: Crop rotation, disease-free seed, and use of resistant varieties. Seed treatments not known to control the seed-borne infection perfectly.

Stem rust (*Puccinia graminis*).—Widespread.

Control: See Wheat.

Stripe disease (*Helminthosporium gramineum*).—Generally distributed. Yellowish to brown or almost black

longitudinal stripes, usually in all but first leaves. Practically all culms of attacked plants are affected similarly. Plants die and crinkle down before maturity.

Control: Use stripe-free seed, or soak seed for one hour in 0.3 per cent water solution of Germisan, Semesan, Uspulun, or 0.2 per cent Corona No. 620.

Stripe rust (*Puccinia glumarum*).—Western States and Black Hills, S. Dak. Leaves, leaf sheaths, and culms affected with long, stripelike lesions of bright yellow uredinia. Under favorable conditions for rust black or winter spore stage may develop black stripes beneath the epidermis.

Control: Many varieties of barley are resistant. Disease of little or no economic importance in this country.

Corn—*Bacterial wilt* (*Aplanobacter stewarti*).—Less important than on sweet corn. (See .774.)

Brown spot (*Physoderma zeæ-maydis*).—Reported from New Jersey and Maryland to Nebraska and South. Not usually important except in the South. Brown spots on leaves, sheaths, and stalks, usually more abundant on lower half of plant.

Control: Crop rotation. Plow under old cornstalks, or otherwise remove them. Avoid using infested manure on land to be planted to corn.

Black-bundle disease (*Cephalosporium acremonium*).—Reported from a number of States, chiefly in the North Central section, but probably occurs generally. Blackened bundles in stalks, usually together with a purplish color in plants, excessive suckering, absence of ears, nubbin ears, or multiplicity of ears, or most of these. Occasionally premature death of plants.

Control: Avoid selecting seed ears from stalks having any of the external symptoms accompanying this disease, and take other precautions mentioned under root, stalk, and ear rots.

Root, stalk, and ear rots (*Diplodia zeæ, Gibberella saubinetii, and others*).—Prevalent and troublesome generally east of the Great Plains. Seedlings may be killed, resulting in a poor stand in the field, or seedlings and developing plants may become more or less weakened, stunted, and off color. Attacked plants have weakened root systems, may show internal discolorations, especially at lower nodes, may show various kinds of "leaf firing," and may die prematurely. Ear development varies from absence to almost normal.

Control: Use resistant strains of corn, as far as possible. Select seed in the field before hard frost, gathering four or five times as much as will be needed. Select seed ears from healthy stalks, always avoiding prematurely dead stalks. Dry selected seed ears promptly. During early part of winter examine each selected ear carefully and discard undesired types, later using modified rag-doll or special table germinator in a warm room, making germination test of each ear. Discard those ears which show weak or diseased seedlings. Save for seed those ears showing 100 per cent germination and vigorous, healthy seedlings. Preferably, shell each ear by hand, discarding any ear found to be too starchy or otherwise unsatisfactory. Grade the shelled corn carefully. Practice approved crop rotation, and keep soil properly fertilized and in good physical condition. (14).

Rust (*Puccinia sorghi*).—Occurs east of the Rocky Mountains and in California. Not important. Reddish-brown eruption of leaf epidermis, forming rust-spore pustules. Sometimes causes death of leaves and seriously stunts young plants.

Control: Breeding and selection of rust-resistant strains of corn.

Smut (*Ustilago zeæ*).—Common wherever corn is grown. Grayish-white galls develop on any part of the plant above ground. Galls largest on stalk and ear. Mature galls are almost black and are filled with a black, dustlike mass of spores of the smut fungus.

Control: May be reduced, but not fully controlled by crop rotation and by rogueing out and burning diseased plants before the smut galls mature.

Oats—*Blast.*—Occurs generally. Various spikelets of panicle fail to develop.

Control: No control measures are known.

Crown rust (*Puccinia coronata*).—Found wherever oats are grown, usually most important in the South. Leaves, leaf sheaths, and glumes affected with few to many bright yellow, open rust pustules, sometimes rendering whole plant decidedly yellow. Such plants are seriously stunted, and their yield is reduced to practically nothing.

Control: Breeding and selection for varietal resistance only known method of control.

Halo blight (*Bacterium coronafaciens*).—Found mostly east of the Great Plains. Scattered oval or irregular blotches of various sizes on leaves and occasionally on spikelets. Centers of blotches dead and collapsed, margins turgid and yellow green in color.

Control: Standard seed treatments reduce, but do not fully control the seed-borne infection.

Loose and covered smuts (*Ustilago avenæ and U. levis*).—Found wherever oats are grown. Heads smutty. Floral parts destroyed and masses of black smut spores produced.

Control: Sow clean seed, or treat seed with formaldehyde. Semesan, Corona No. 620, Uspulun, and Germisan are effective when the seed is soaked two hours in 0.3 per cent solution. (12).

Stem rust (*Puccinia graminis*).—Occurs throughout the country.

Control: See Wheat.

Rice—*Rotten neck* (*Piricularia grisea*).—General. Brown spots on leaves and glumes and brown rotting of peduncle or neck just below head, causing head to die and sometimes to break over.

Control: No satisfactory control measure.

Sclerotium seedling blight (*Sclerotium rolfsii*).—Reported only from Louisiana. Blighting of seedlings previous to irrigation, together with dark, moldy appearance and often spherical mustard-seedlike bodies at base of blighted seedlings.

Control: Irrigate as early as possible.

Sclerotium stem rot (*Sclerotium oryzæ*).—Reported from South Carolina, Louisiana, and Arkansas. Rotting of stem at water line and lodging of plants just before maturity.

Control: No satisfactory control measure.

Straight head.—Cause not known. Occurs in all rice-growing States. Heads fail to fill, remain erect and green. Glumes abnormal.

Control: Special methods of irrigation to obtain proper soil aeration.

Rye—*Ergot* (*Claviceps purpurea*).—General. Purplish black, hornlike structures, called sclerotia, develop in the spikelets in place of kernels. Usually the ergot bodies or sclerotia are several times as large as the kernels and therefore protrude conspicuously from the spikelets.

Control: Use ergot-free seed. Rotate crops. Keep down wild grasses around the field.

Leaf rust (*Puccinia dispersa*).—General. Affected plants show few to many orange-colored, open pustules

of rust spores. Seriously rusted plants become stunted and produce few culms with shortened heads.

Control: Breeding and selection for resistant strains.

Nematode disease (*Tylenchus tritici*).—Virginia. Same as on wheat in seedling stage. Ripe heads contain galls lighter in color and smaller than those in wheat.

Control: Same as for wheat.

Scab (*Gibberella saubinetii*).—Found in most rye States east of the Great Plains. Usually not important.

Control: See Wheat.

Stem smut (*Urocystis occulta*).—Occurs generally from the Great Plains east. Black stripes running lengthwise of stems and leaves, more noticeable on stems. Stripes filled with black smut spores.

Control: Sow clean seed or treat seed with copper-sulphate lime solution, or dust with copper carbonate at the rate of 2 ounces per bushel.

Stem rust (*Puccinia graminis*).—Occurs generally.

Control: See Wheat.

Wheat—*Bunt or stinking smut* (*Tilletia lævis* and *T. tritici*).—Occurs wherever wheat is grown. Bunt caused by *T. tritici* is most severe in the far West, and that due to *T. lævis* is confined largely to the Central and Eastern States. Diseased heads produce smut galls instead of sound kernels. These galls are filled with black smut spores, which have a fetid odor.

Control: Sow clean seed or treat smutty seed with copper-carbonate dust at the rate of 2 to 3 ounces per bushel. Copper-sulphate lime, and formaldehyde solutions are also used. Grow resistant varieties where adapted. (12), (62).

Black chaff (*Bacterium translucens undulosum*).—Mississippi Valley and Great Plains area. Translucent to brown spots scattered on leaves, and dark brown to black streaks on "neck" and outer glumes.

Control: Use disease-free seed.

Downy mildew (*Sclerospora macrospora*).—Kentucky, Tennessee, and California. Affected plants become dwarfed, leaves abnormally thickened, more or less twisted and curled, and heads variously deformed, together with abnormal color, bluish-green to yellow throughout. Many plants fail to produce heads.

Control: No adequate control yet known.

Ergot (*Claviceps purpurea*).—Occurs scatteringly, but is troublesome only in the durum wheat regions of North Dakota and Minnesota.

Control: See Rye.

Flag smut (*Urocystis tritici*).—Illinois, Missouri, and Kansas. Black smut stripes running lengthwise of leaf, sheath, and stem. Stripes filled with masses of black spores. Diseased plants seldom head.

Control: Sow clean seed or treat seed with copper carbonate or copper-sulphate lime. Plant resistant varieties. (13).

Glume blotch (*Septoria nodorum*).—Occurs in most States east of the Great Plains. Brown blotches on glumes, accompanied with considerable shriveling of kernels in later stages.

Control: No adequate control measures known.

Helminthosporium foot rot (*Helminthosporium sativum*).—Found especially in the North Central States, but reported also from others throughout the country. Brown rot of underground parts, sometimes killing seedlings; brown spots with bleached centers in leaves; and dark-brown tips of kernels.

Control: Crop rotation, disease-free seed, and use of resistant varieties. Seed treatments not known to control seed-borne infection perfectly.

Leaf rust (*Puccinia triticina*).—Occurs wherever wheat is grown. Affected plants show few to many orange-colored, open pustules of rust spores. Seriously rusted plants become stunted and produce few culms with shortened heads.

Control: Breeding and selection for resistant strains.

Loose smut (*Ustilago tritici*).—Occurs wherever wheat is grown. Heads of infected plants produce loose masses of black smut spores. The floral parts are completely destroyed.

Control: Sow clean seed or treat with hot water and establish smut-free areas for growing clean seed.

Nematode disease (*Tylenchus tritici*).—Occurs in Maryland, West Virginia, Virginia, the Carolinas, and Georgia. Seedlings often stunted and gnarled, leaves rolled and wrinkled, and stems often crooked. Ripe heads contain dark galls instead of kernels.

Control: Rotate crops, keeping wheat and rye or infested crop refuse off land for one or preferably two years before sowing wheat. Sow only uninfested seed.

Powdery mildew (*Erysiphe graminis*).—Occurs in almost every State where wheat is grown. Superficial, fluffy, grayish-white patches appear on leaves; later, small, spherical black bodies (perithecia) form within the patches.

Control: No adequate control feasible, although certain varieties are somewhat resistant.

Rosette (*a virus disease*).—Found in Indiana and Illinois. Rosette usually occurs in spots in the field. Affected winter-wheat plants show marked stunting, characteristic bluish-green color, and excessive tillering in spring when healthy plants are resuming normal growth. Some diseased plants may die; others commonly produce new tillers which usually form only small, poorly filled heads. The virus persists many years in the soil.

Control: Resistant or immune varieties.

Scab (*Gibberella saubinetii*).—Present in all wheat States from North Dakota to Texas and east, also Montana and Colorado. Most often troublesome in the Corn Belt States. Attacks heads, blighting individual spikelets, groups of spikelets, or the entire spike. Killed portions become straw colored, and a slight salmon-pink growth may become evident between the glumes, especially at their bases. Occasionally small, bluish-black, spherical bodies may develop on affected parts if the weather is moist. Attacked kernels are grayish-white to pinkish, usually badly shrunken and very light in weight. Also attacks seedlings, causing light-brown rot of underground parts. Some are killed.

Control: In sections where disease is important, avoid sowing wheat after corn. Use as clean seed as possible that has been treated for 30 minutes with a 0.6 per cent solution of Semesan, Uspulun, or Germisan.

Speckled leaf blotch (*Septoria tritici*).—Reported from almost every State where wheat is grown. Light-brown blotches in leaves usually containing scattered, dark-colored bodies (pycnidia).

Control: No adequate control measures are known.

Stripe rust (*Puccinia glumarum*).—Occurs in Western States only. Leaves, leaf sheaths, culms, and sometimes glumes affected with long, bright, stripelike lesions consisting of open pustules of rust. Plants of highly susceptible varieties sometimes produce badly shriveled kernels.

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Control: Most varieties of wheat are resistant to this disease. Disease is of little or no economic importance in this country.

Stem rust (*Puccinia graminis*).—Found wherever wheat is grown, but is most important in the spring-wheat area. Rusted plants show few to many reddish-brown to black open pustules of rust spores on leaves, leaf sheaths, and culms. Disease especially serious when infection breaks out on neck. Kernels of rusted plants sometimes are of light weight and badly shriveled.

Control: Eradication of the common barberry, in the North Central States. Breeding and selection for rust-resistant hybrids and varieties.

Take-all (*Ophiobolus graminis*).—Found in New York, Maryland, Virginia, Tennessee, North Carolina, Arkansas, Indiana, Kansas, and Pacific Coast States. Take-all usually occurs in spots in the field. Affected plants fail to tiller normally, remain upright, rather rigid, become variously yellowed and dwarfed and, in centers of spots, die before heading. At margins of the spots, or variously scattered throughout the field, the affected plants may die and bleach out just after heading. Affected plants have blackened bases, and a delicate, black crust of the causal fungus occurs on the stem inside the basal sheath.

Control: Keep wheat and barley off infested land for four or five years.

Forage Crops

Alfalfa—*Bacterial blight* (*Bacterium medicaginis*).—Plants dwarfed and yellowish. Stems show yellowish or watery lesions, which later become brown or black. Reported as serious in the Western States following late frost in spring.

Control: Unnecessary; usually disappears after first cutting.

Bacterial wilt (*Aplanobacter insidiosum.*)—Plants wilt in hot weather or produce dwarfed, spindling growth. Discolored wood beneath the bark of taproot. Widely distributed.

Control: Rotate. Try hardy varieties in Northern States.

Crown rot (*Sclerotinia trifoliorum*).—Occurs in eastern United States and Pacific Northwest.

Control: See Clover.

Crown wart (*Urophlyctis alfalfæ*).—Reported west of the Rocky Mountains, and in Indiana, Mississippi, and Alabama. Plants dwarfed. Warty outgrowths at crown.

Control: Plow under badly diseased areas, and do not replant to alfalfa for several years.

Dodder (*Cuscuta sp.*)—Occasionally troublesome in individual fields.

Control: See Clover.

Leaf spot (*Pseudopeziza medicaginis, Pyrenopeziza medicaginis, and others*).—Common in all sections. Gray or brown spots on leaves, afterwards accompanied by yellowing of leaves and defoliation.

Control: Cut early. Soil treatments to induce vigorous growth of plants.

Violet root rot (*Rhizoctonia crocorum*).—Central United States and Pacific Northwest. Dwarfing and wilting of plants. Roots decayed. Mats of dark mycelium on roots.

Control: See Crown wart.

Winter injury.—Plants killed or injured in varying degrees during winter. Badly injured plants may wilt and die as soon as the soil becomes warm and dry. Plants less seriously injured may live indefinitely.

Control: Plant seed grown from hardy stock.

Yellow-top (associated with leaf hopper, Empoasca fabæ).—Widespread, especially in Eastern States. Causes yellowing or bronzing of leaves and extreme dwarfing of plants. Crop usually recovers in late summer or fall.

Control: None.

Clover—*Anthracnose (Colletotrichum trifolii, Gloeosporium caulivorum)*.—Occurs in eastern United States. Probably the most important clover disease. Wilting of stems and leaves. Brown lesions on stem and petioles, especially near blossoms or at base of leaflets. Worst during warm weather.

Control: Use resistant varieties. Avoid seed grown in southern Europe.

Crown rot (Sclerotinia trifoliorum).—Found in eastern and northwestern United States. Crown, root, and stem rot, causing death of plants in patches through the field. Black sclerotia often found at base of dead plants. Worst during cool weather.

Control: Plow under badly diseased fields. Use other legumes in rotation.

Dodder (Cuscuta sp.).—Widespread. Yellowish, thread-like growth twining around plants. Occurs in patches through fields.

Control: Sprinkle affected patches with oil; or cover with straw and burn. Use seed free from dodder seed.

Mosaic (a virus disease).—Occurs scatteringly; usually not important. Cause not determined. Leaves mottled with dark and light-green, irregular patches. Plants often dwarfed.

Control: None.

Powdery mildew (Erysiphe polygoni).—General in the United States and Canada. White, powdery mold growing over leaves, often giving field appearance of having been dusted with a white powder.

Control: No control. Early cutting may check loss of lower leaves.

Rust (Uromyces trifolii).—Widespread. Reddish or brown spots on leaves and stem.

Control: None.

Sooty blotch (Phyllachora trifolii, Polythrincium trifolii).—Occurs widely. Black spots on undersurfaces of leaves. Worst on alsike, white, and crimson clover.

Control: None.

Tip-burn and yellowing.—(See Alfalfa Yellow-Top.)

Winter injury.—Plants killed in winter or slow in starting to grow in spring.

Control: See Alfalfa.

Cowpea—*Leaf spots (Cercospora cruenta, Amerosporium œconomicum)*.—General with the crop. Yellowish or brown spots, which may dry out and cause leaf to fall prematurely.

Control: Use resistant varieties.

Mosaic.—See Clover.

Powdery mildew (Erysiphe polygoni, Microsphæra euphorbiæ).—Found in eastern and southern United States.

Control: See Clover.

Root knot (Heterodera radicicola).—Common in Southern States. Plants dwarfed. Root galls found on taproots and lateral roots.

Control: Use resistant varieties.

Rust (Uromyces vignæ).—Widespread, especially in South. Reddish or brown spots on leaves and stems.

Control: Use resistant varieties.

Wilt (Fusarium vasinfectum).—Southern States and California. Leaves become yellow, wilt, fall off, and plant usually dies.

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Control: Use resistant varieties.

Sorghum—*Bacterial disease* (*Bacterium andropogoni*).—Rather general in occurrence. Water-soaked yellow or purple-red streaks in the leaf blades and sheaths, together with crusts or scales of bacterial exudate usually on lower surface of the blades.

Control: No adequate control known.

Head smut (*Sorosporium reilianum*).—Rather widely reported, but apparently of only local importance, in Kansas, Oklahoma, and Texas. Infected culms branch abnormally. Smutty heads. Floral organs are almost completely destroyed.

Control: Grow resistant varieties where practicable.

Kernel smuts (*covered smut, Sphacelotheca sorghi; loose smut, S. cruenta*).—*S. sorghi* is found in most of the States where sorghum is grown. *S. cruenta* is found rarely. Infected heads produce irregular-shaped smut galls instead of sound kernels. These galls, when mature, are filled with black masses of smut spores.

Control: Sow clean seed if available. Soak smutty seed for 15 to 30 minutes in formaldehyde solution (1 pint to 30 gallons of water), or mix thoroughly with copper-carbonate dust (2 ounces per bushel). Grow resistant varieties.

Soy Bean—*Bacterial blight* (*Bacterium sp.*).—Widespread. Several distinct bacterial diseases have been reported, having slightly different symptoms on leaves stems, and pods. Angular, translucent, later yellow or reddish-brown spots. Leaves may become yellow.

Control: Rotation; clean seed.

Bacterial pustule (*Bacterium phaseoli sojense*).—Occurs in Arkansas, Kansas, Louisiana, Texas, Delaware, Virginia, Maryland, and the Carolinas. Irregular, reddish-brown spots on leaves characterized when young by tiny pustules, which later slough off. Spots become confluent, often covering a considerable portion of the leaf and accompanied by conspicuous yellowing. Brown or black spots on pods and seeds.

Control: Rotation of crops and use of seed from disease-free fields is recommended. No specific control measures have been worked out.

Mosaic.—See Clover.

Root knot.—See Cowpea.

Stem rot (*Sclerotium rolfsii*).—General in Southern States. Plants gradually wilt and die; roots and stems decay. Mycelium and sclerotia occur at the soil surface at the base of diseased plants.

Control: No adequate control known. Liming of acid soils recommended.

Wilt.—See Cowpea.

FIBER PLANTS

Cotton (15), (31)—*Anthracnose* (*Glomerella gossypii*).—Widespread. Most conspicuous on bolls, where it causes spots. These at first are small and water-soaked, but later become larger and black and have reddish borders and pink centers.

Control: Rotate crops. Do not plant on land where the disease occurred the previous season. Plant varieties most resistant to anthracnose and only seed selected from healthy plants.

Bacterial blight (*Bacterium malvacearum*).—Widespread. Causes on the leaves small, irregular, angular spots, which at first are water-soaked, later reddish brown. On bolls rounded spots occur, at first water-soaked, later enlarging, becoming black and sunken, and sometimes rotting entire boll. Blackens and kills stems and boll pedicels.

Control: Rotate crops. Plant disease-free seed selected from healthy fields or plants.

Root knot (*nematodes, Heterodera radicicola*).—Common in sandy soils of the South and the Southwest. Plants are stunted and the roots covered with galls up to half an inch in diameter.

Control: Plant root-knot-immune crops, such as grasses, grains, and resistant legumes, on diseased fields for one or more years to starve out the nematodes before growing susceptible crops.

Rust.—General on poor lands. Caused by lack of humus, of potash, and of drainage. Plants stunted; leaves turn yellow-mottled, then reddish-brown, curl up, and drop off early.

Control: Add humus to the soil by plowing under green manures or stable manure. Use fertilizers containing potash, and drain wet fields.

Texas root-rot (*Ozonium omnivorum*).—Found especially in Texas, New Mexico, and Arizona. Plants wilt suddenly, and leaves dry up, preventing maturity of cotton. Disease spreads in rounded or irregular patches from plants first attacked. Taproot usually attacked first near the surface of the ground, where it becomes shrunken with reddish border.

Control: Entirely satisfactory control not known. Pull all host plants of Ozonium in fields in the fall, allow to dry out thoroughly from three to four weeks, then plow under. Rotate with immune crops.

Wilt (*Fusarium vasinfectum*).—Found in sandy soils from Virginia to Texas. Plants stunted; wilt and die in irregular spots. The stems of wilted plants are black or brown inside.

Control: Plant only varieties of cotton which are resistant to wilt, such as Dixie, Dixie-Triumph, and Dixie-Cook. Other resistant varieties have been bred by experiment stations and individual farmers.

Flax—*Heat canker.*—Nonparasitic, and occurs in all flax States. Important in Minnesota, the Dakotas, and Montana. Seedlings become girdled at soil line and fall over. Many such seedlings die, while others continue growing slowly, but become stunted plants. Such plants usually show a girdling and commonly a thickening of stem, just above the soil line.

Control: Sow flax sufficiently early to bring seedlings past the susceptible stage before the hot days of June.

Pasmo (*Phlyctæna linicola*).—New to the United States. Found in Michigan, Wisconsin, Minnesota, and

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the Dakotas. Brown spots or areas on leaves and stems, sometimes killing entire top of plant.

Control: Use seed from fields free from pasmo, and sow on uninfested fields.

Rust (*Melampsora lini*).—Generally prevalent and important. Leaves, stems, and bolls of plant show numerous bright-yellow to black swellings and open masses of rust spores. Seed production materially reduced, and fiber much injured.

Control: Breeding and selection for varietal resistance. Spraying is of no avail.

Wilt (*Fusarium lini*).—Generally distributed and important in flax sections. Attacked seedlings or larger plants may wilt comparatively suddenly. On newly infested land, disease occurs in spots and later spreads to entire fields, causing total loss of crop when susceptible varieties are used.

Control: Use resistant varieties.

FOREST TREES, SHADE TREES, AND OTHER ORNAMENTAL PLANTS

General

Damping off.—Caused by several different kinds of fungi that attack seedlings and softwood cuttings. Especially common in seedlings of conifers and rhododendron up to the age of four or five weeks. Under glass, fungi attack the leaves, spreading directly from one plant to another through the tops. In the open usually the roots are first attacked. Lime or wood ashes, and poorly rotted organic matter such as dried blood or fresh manure, aggravate the disease and should be avoided. There is less damping off of the conifers and heaths in acid soils than in alkaline soils.

Control: The remedy, for plants under glass, is ventilation, to avoid excessively moist air. To prevent the root type of damping off, disinfect the beds. One-eighth fluid ounce of the strongest commercial sulphuric acid in a pint of water can be applied per square foot of bed, just after the seed is sown and covered, or one-third fluid ounce of formaldehyde in a pint of water may be used per square foot of bed, applied 10 days before seed is sown. Use the acid for conifers and heaths only. Formaldehyde may be applied to any kind of plant. Test on a small scale at each nursery, before using on a large scale. The soil-disinfectant treatments often are valuable for the weed control that they give, in addition to their effect on the disease.

Forest and Shade Trees

Forest Trees.—Trees have numerous leaf, twig, trunk, and root diseases, varying in severity from leaf spots, which only slow up the rate of growth, to such killing diseases as chestnut blight. The control of some of these diseases, such as white-pine blister rust, is comparatively simple, but for many others there is no practical method of control. Root diseases, which are the cause of a large part of the loss of trees by wind throw, are especially difficult to control. Closely related to root diseases and often caused by the same organisms are diseases that directly produce decay in the merchantable parts of the tree trunks. This type of disease plays a major rôle in making wood lots unprofitable, often producing a cull or loss from decay amounting to 20 or 30 per cent of the value of the stand at the time of cutting. These decay fungi enter the trunks in various ways—through fire scars, lightning injuries, and other wounds, knot holes, old stumps, and roots. Fungous organisms sometimes utilize more than one means of entrance. The loss which these fungi produce can often be lessened greatly by the observance of certain general rules of forest sanitation, protection, and utilization:

(1) By preventing forest fires the woodland owner can eliminate one important mode of entrance for decay fungi—fire scars. (2) By care in logging operations he can lessen the number of wounds on the trees left standing. (3) If he cuts trees so that the stumps are low, decay is less likely to spread from the old stumps to the growing sprouts. (4) By removing the diseased trees in all cutting and thinning operations the owner can largely eliminate the source of infection for healthy trees. It is

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often difficult to detect decay in trees, but hollows at the base of trees or high up in the trunks, open fire scars, fruiting bodies (conks, punks) of decay fungi on the trunk, and hollow sound produced when the tree is struck with an ax are the surest indications of it. In such trees the decay is usually progressing faster than new wood is forming. Severely wounded, dead, and wind-thrown trees should also be removed. Trees which, because of crowding or some other unfavorable factors, are in danger of dying before the next proposed cutting time, should be utilized, since decay and other factors rapidly render a dead tree worthless. Trees that are making very slow growth, especially those that have many large dead limbs, are usually more susceptible to decay than vigorously growing trees and should be cut in thinning operations. (5) For forest plantings it is often advisable to use a mixture of species, so that if one species is seriously affected by decay or other diseases a full stand can still be obtained. Diseases develop less abundantly in mixed stands than in pure stands.

Shade Trees—*Wood decay.*—Decayed spots in trees arise from various sorts of injuries that have been neglected or as a result of disease.

Control: Clean out the decayed area, and treat in accordance with the usual plan of procedure. A badly decayed tree should be replaced with a new and healthy one, unless there is some very special reason for trying to prolong its life. (16).

Nonparasitic (excessive drying).—Affects both deciduous and coniferous trees, such as maples, oaks, beeches, and arborvitæ. Pale yellow or brown leaves scattered over the tree. Leaves of many deciduous trees have a mottled appearance or large irregular blotches. Top branches may lose their leaves and eventually die, causing a stag-headed appearance of the crown. This is the direct result of the failure of the tree to get a sufficient supply of soil moisture and may be brought about through unfavorable conditions, due to improper methods of transplanting, to change of grade about the tree trunks, to street pavements or cement sidewalks covering the soil about the roots, or to thinning of trees in forest areas and consequent change of exposure.

Control: Employ methods that will tend to promote the general health of the tree, such as cultivation of the soil about trees, enriching with fertilizers, rich loam, or well-rotted manure, or even renewal of the soil. Apply water as needed during dry periods.

Deciduous Trees

Ash—*Rust* (*Puccinia fraxinata*).—Found in the Eastern and Central States. Irregular swellings on twigs and petioles. Also attacks the leaves. Affected areas covered with yellow pustules. Requires marsh or cord grass as alternate host.

Control: Trees should not be grown in or near marshy land.

Catalpa—*Leaf spot* (*Phyllosticta catalpæ*).—Found in Eastern, Southern, and Central States. Circular brown spots scattered over leaf surface, slightly depressed, causing wrinkling of leaf. If very numerous, the spots coalesce.

Control: Spray trees with Bordeaux (2–2–50) at intervals of about two weeks during the summer. Use Bordeaux (4–4–50) in fall and early spring. Keep soil cultivated about the trees.

Elm—*Leaf spot* (*Gnomonia ulmea*).—Occurs in Eastern and Central States. Gray and black spots on upper surfaces of leaves. If severely infected, leaves turn brown and fall early.

Control: Rake up and burn all fallen leaves. Spray in early spring, before growth begins, with Bordeaux (4–4–50). A second or third application may be necessary before midsummer.

Horse-Chestnut—*Leaf blotch* (*Guignardia æsculi*).—Occurs in the Eastern, Southern, and Central States. Reddish-brown, irregular blotches on leaflets, surrounded by yellowish zone merging into the green of leaflets. Greater part of leaf surface may be discolored. Leaves begin to fall early—by last of August. Occurs only on buckeye.

Control: Spray with Bordeaux (4–4–50). Infected nursery stock should be dusted with mixture of 9 parts finely ground sulphur and 1 part arsenate of lead. Rake up and burn all fallen leaves in autumn.

Maple—*Wilt* (*Verticillium*).—Found in eastern United States. Leaves on individual limbs or parts of tree wilt and die. Fungus grows in sapwood of tree, producing characteristic dark-green streaks.

Control: Not successful on individual trees. Wilted limbs should be burned and wounds painted. Often best to remove tree immediately to retard infection of surrounding healthy trees.

Anthracnose (*Glœosporium apocryptum*).—Occurs in eastern United States. Irregular, brown blotches extending from margins of leaves downward along veins. Moist weather favors its spread.

Control: Spray trees in early spring with Bordeaux (4–4–50). Two or three applications may be necessary. Rake up and burn all infected leaves.

Leaf spot (*Phyllosticta minima*).—Occurs in eastern United States. Light-brown circular spots with dark, reddish-brown margins. Common on red and white maples.

Control: Destroy by burning all falling leaves.

Tar spot (*Rhytisma acerinum*).—Found in Eastern and Central States. First appears as light-green or yellowish spots, which become black, resembling tar. Leaves fall early. Affects only white and red maples.

Control: Rake up and burn all fallen leaves. Spray with Bordeaux (4–4–50) in early spring before growth begins.

Oak—*Anthracnose* (*Gnomonia veneta*).—Occurs in Eastern and Central States. White oaks particularly susceptible. Brown blotches or spots of irregular shape, particularly along veins of leaves. Moist weather favors spread of disease.

Control: Spray trees with Bordeaux (4–4–50) before growth begins in spring at intervals of two weeks. Spray again in fall, and also rake up and burn fallen leaves.

Leaf blister (*Taphrina cærulescens*).—Found throughout the United States. Begins as yellowish spots on upper leaf surface, which increase in size until leaf tissue bulges out, the convex side usually on upper surface. Curling of leaves may result.

Control: Spray with Bordeaux (4–4–50) after leaves fall and before buds swell. Rake up and burn fallen leaves.

Poplar—*Canker* (*Dothichiza populea*).—Occurs in Eastern and Central States. Depressed cankers form on bark of twigs and branches. Small gray-black pustules appear on affected areas.

Control: Control is difficult. Disease often can be checked by pruning out all diseased twigs and branches. Protect all cut surfaces by painting. Spray trees when dormant with Bordeaux (4–4–50).

Sycamore—*Anthracnose* (*Gnomonia veneta*).—Symptoms and control same as for oak.

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Chestnut—*Blight* (*Endothia parasitica*).—Present in all Eastern States that have extensive chestnut growth. Canker on limbs and trunk which enlarge until girdle is completed. Leaves on girdled parts turn brown.

Control: No control of this disease in native chestnut forests. Each owner should plan to utilize his chestnut stand before the trees are killed. Ornamental Japanese and hairy Chinese chestnuts usually can be saved if affected limbs and trunk cankers are removed as soon as noted and all wounds painted.

Evergreens

Red Cedar—*Cedar apple.*—See .4124 and .51.

Juniper—*Cedar apple.*—See .4124 and .51.

White Pine—*Blister rust* (*Cronartium ribicola*).—Occurs in the New England States, New Jersey, Pennsylvania, Michigan, Wisconsin, Minnesota, Washington, and Oregon. In Canada it occurs in the Provinces of British Columbia, Ontario, Quebec, Prince Edward Island, New Brunswick, and Nova Scotia. Disease was introduced into this country from Europe and apparently is of Asiatic origin. On currant and gooseberry bushes, from June to October, the disease appears as an orange-yellow rust on the under side of the leaves. Spores from diseased bushes infect white pines through their needles, and the fungus grows into the bark, producing cankers on the branches and trunk. The cankers are not readily recognized until about three years after infection. They then usually appear as spindle-shaped swellings on the branches of the trunk. The edges of the cankers are marked with a yellowish-green or orange discoloration. From April to June blisters about the size of a navy bean burst through the diseased bark. These blisters are full of orange-yellow spores. The blisters break open and the spores infect the leaves of currant and gooseberry plants. The ruptured bark dies after the spores are discharged. The fungus continues to grow into the live bark and each year new blisters are produced until the branch or tree is killed. The bark of old cankers is irregularly cracked, rough, and scaly in appearance. Sometimes rodents eat the diseased bark, leaving barkless patches of white wood. These patches turn dark gray in color, and the canker becomes more or less covered with white streaks of dry pitch. Many diseased trees under 10 years of age have a stunted, bushy growth and a yellowish color. On older trees the first indication of damage appears as scattered dead and dying branches. The damage becomes more apparent with the continued development of the disease, until the tree dies.

Control: Blister rust spreads from one currant or gooseberry bush to another, but can not spread from one pine to another. It can infect pines only through the medium of currants and gooseberries. The rust can be controlled effectively in pine stands by systematic eradication of all species of currant and gooseberry bushes within a short radius of the trees. The exact distance varies with local conditions, but ordinarily a distance of 900 feet will be sufficient to protect the pines. Cultivated black currants (*Ribes nigrum*) should be eradicated within a radius of 1 mile. The black currant is more susceptible to the disease than other species of currants and gooseberries and is an important factor in its spread over long distances and its local establishment.

Ornamental Small Conifers—*Blight* (*Phomopsis juniperovora*).—Occurs in Eastern and Middle Western States and extends throughout the South to the Gulf coast.

Fungus blights the tender growth of young stock, producing a canker on the stems of junipers, arbor-vitæ, cypress, Retinospora, Cryptomeria, and Taxus.

Control: Spray systematically with Bordeaux (5–5–50), beginning early in season. Add 1 pound resin fish-oil soap to every 25 gallons as an adhesive. Destroy badly blighted stock.

Shrubs

Hydrangea—*Leaf spot* (*Phyllosticta hydrangeæ*).—Common. Rusty-brown spots on leaves, or blighting of entire tops.

Control: Spray with Bordeaux or lime-sulphur.

Lilac—*Mildew* (*Microsphæra alni*).—Common wherever lilac is grown. Whitish, cobwebby growth on surface of leaves, which gives them a dusty appearance.

Control: Dust with mixture of 9 parts finely ground sulphur and 1 part arsenate of lead at intervals of about two weeks during the summer. Spray with Bordeaux (4–4–50) when leaves fall in autumn and again in the spring before growth commences.

Rose—*Black spot* (*Diplocarpon rosæ*).—Found wherever rose is grown. Purplish-black spots that have irregular ringed margins appear on upper leaf surface. Leaves turn yellow and fall early.

Control: Dust with mixture of 9 parts finely ground sulphur and 1 part arsenate of lead at intervals of two weeks during the growing season. Spray with Bordeaux (4–4–50) when plants are dormant. Rake up and burn infected leaves. Grow more resistant varieties and keep plants healthy by cultivation, and by winter protection if necessary.

Mildew (*Sphærotheca pannosa*).—Occurs wherever rose is grown. Whitish or grayish patches on leaves give them a powdery appearance. Leaves curl, die, and fall. Thorns, shoots, and even buds may be affected.

Control: Use same method as for black spot.

Boxwood—*Leaf blight* (*Macrophoma candollei*).—Distribution wherever boxwood is grown. Leaves turn yellow and are covered with small, black pustules. Defoliation results.

Control: Rake up and burn fallen leaves. Spray plants with Bordeaux (4–4–40) in the fall and before growth begins in the spring. A weaker solution (2–2–50) may be used during the growing season.

Vines

Sweet Pea—*Anthracnose* (*Glomerella rufomaculans*).—Most widespread of field diseases. Whitish spots on leaves, stems, flowers, and pods, sometimes causing entire branches to wither.

Control: Select seed from unspotted pods. Avoid samples containing shriveled seed. Treat seed with formaldehyde or sulphuric acid. Avoid wetting foliage in watering, or picking when foliage is wet with dew.

Powdery mildew (*Microsphæra alni*).—Yellow patches on upper surface of leaves, becoming powdery below.

Control: Spray with Bordeaux or lime-sulphur.

Streak (*Bacillus lathyri*).—Found in Delaware and Pennsylvania. Unimportant disease. Reddish brown to purple, elongated spots on stems, leaves, and blossoms.

Control: Change of soil in bed or sterilization by steam.

Wilt and root rot (*Fusarium, Thielavia, Rhizoctonia*).—Principal greenhouse disease. Sudden wilting or

gradual decline of plants. Stem and underground parts rotted.

Control: Change of soil, or soil sterilization. Avoid excessive watering in dull weather.

Herbaceous Perennials

Carnation—*Bud rot* (*Sporotrichum anthophilum*).—The buds rot or fail to open.

Control: Avoid excessive watering. Remove and destroy affected parts.

Rust (*Uromyces caryophyllinus*).—Quite common on greenhouse carnations. Brown, powdery rust pustules on leaves, usually elongated parallel with the axis.

Control: Use resistant varieties. Control the watering.

Stem and root rot (*Corticium vagum*).—Reported generally. Important greenhouse trouble. Stems and roots show brown fungous threads on the surface, and are stunted or bushy.

Control: Remove and destroy affected plants. Change or sterilize the soil in flower beds.

Wilt (*Fusarium sp.*).—Commonly troublesome in greenhouses. Stem rotted at base, and vascular bundles browned. Plants are unthrifty, or wither and die.

Control: Change or sterilize soil in beds, avoid overwatering, remove affected plants, and propagate only from thrifty plants.

Hollyhock—*Rust* (*Puccinia malvacearum*).—Common and troublesome whenever hollyhocks are grown. Leaves bear yellow to brown rust pustules.

Control: Remove and destroy affected leaves. Use clean culture to avoid contaminating soil with diseased parts. Dust with sulphur in the spring. Destroy weeds related to hollyhock, like round-leaved mallow.

Iris—*Leaf spot* (*Heterosporium gracile*).—Elliptical, brown, yellow-bordered spots on leaves.

Control: Destroy diseased foliage in the fall. Use clean culture about the plants. Use liberal quantity of lime for most kinds of iris.

Rootstock rot (*Bacillus carotovorus*).—Generally prevalent. Rot of underground parts.

Control: Remove and destroy all of the affected plant.

Peony—*Botrytis blight* (*Botrytis pæoniæ*).—Widely distributed and important. Brownish or grayish spots on stems and leaves. Buds rot without opening.

Control: Remove, by cutting, all diseased parts. Avoid overcrowding, excessive watering, and heavy mulching with manure. Use clean culture. Spray with Bordeaux.

Delphinium—*Black disease*.—Caused by mite injury. Inflorescence aborts and turns black; leaves also affected, becoming thickened anl curled, mostly at margins. Mites are small and easily overlooked, so the symptons suggest a fungous disease.

Control: Remove and destroy badly diseased plants. Make repeated and thorough applications of nicotine and soap solution or nicotine dust.

Black spot (*Bacterium delphinii*).—Occurs principally in Northeastern States. Black spots of irregular shape, sometimes zonate, on leaves.

Control: Remove affected foliage. Use clean culture. Cut badly affected plants to the ground, since new sprouts frequently come clean.

Root rot (*Sclerotium delphinii*).—Occurs chiefly in old plantings where soil is poorly drained and cultivated or lacks lime. Tops wither and die. Basal and underground parts rotted.

Control: Provide better drainage, particularly of surface, give clean cultivation, and sprinkle lime about the crown, or change site, starting with healthy plants.

Annuals

Aster—*Wilt* (*Fusarium conglutinans var. collistephi*).—Widespread in occurrence and important. Wilting and death of plant, stem rotted at ground line, and bark and vascular bundles discolored.

Control: Avoid infested soil, or use formaldehyde drench to sterilize aster beds. Disinfect seed. Avoid transplanting, if possible, or transplant in such a way as to give minimum setback. Practice one-year rotation of aster beds.

Yellows (*a virus disease*).—Coextensive with aster culture, at least in the eastern United States. Plants spindling, unsymmetrical; foliage yellow; blossoms distorted, greenish color, never expanding. Affects many other plants similarly, such as wild asters and daisies. Same as Rio Grande disease of lettuce. Causative agent spread by a leaf hopper; the disease persists over winter in various perennial plants.

Control: Destroy weeds that show symptoms of yellows. Remove affected asters at first appearance of disease. Spray or dust with nicotine to kill insects.

Snapdragon—*Anthracnose* (*Colletotrichum antirrhini*).—Prevalent in the North Atlantic and the Lake States. Brown-bordered white spots on leaves and stems.

Control: Propagate from disease-free stock. Avoid wetting plants when watering. Spray with Bordeaux.

Rust (*Puccinia antirrhini*).—Widespread and important locally. Brown, powdery pustules on leaves and stems. Shriveling and death of leaves.

Control: In greenhouses dust with ground sulphur, and raise temperature to 70° F. for a day or so. Outdoors, dust with sulphur during warm weather.

Bulbs

Gladiolus—*Dry rot* (*Sclerotinia sp. ?*).—Probably general, at least throughout the East. Foliage prematurely turns yellow, then brown. Old corm decayed; new corm small, spotted, roots poorly developed.

Control: As for hard rot.

Fusarium rot (*F. oxysporum var. gladioli*).—Widely distributed but usually not abundant. Corms bear reddish-brown lesions beneath the husks, mostly toward the base, characterized by concentric ridges.

Control: As for hard rot.

Hard rot (*Septoria gladioli*).—Generally distributed and probably of considerable importance. Corms have black, hard, sunken spots. Leaves also spotted.

Control: Practice rigid selection to avoid planting even slightly diseased corms. Change planting site at first sign of disease. Remove and destroy plants, including corms, which die down early. Dry and free corms from earth before storing. Store in a cool, dry place.

Scab (*Bacterium marginatum*).—Leaves spotted toward base; brown lesions, cracks, or holes on husks; on the corm the lesions are circular, depressed.

Control: As for hard rot.

Tulip—*Botrytis blight, fire* (*Botrytis tulipæ*).—Widespread in United States. Minute yellow spots on leaves, enlarging to gray, sunken blotches. Small, pimplelike, black granules on base of stalk and bulb scales; brown, scablike lesions underneath scales.

Control: Removal and destruction of diseased plants when they first appear. Select bulbs free from scab lesions and black granules for propagation.

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FRUITS AND NUTS

Pome Fruits

Apple—*Anthracnose* (*Neofabrœa malicorticis*).—See Cankers.

Bitter pit.—General. Brown spots beneath the skin of the apple or scattered through the flesh. Most common on large apples and on fruit from young trees.

Control: Avoid excessive stimulation, and keep the trees in an even condition of growth. Hold the apples at a low temperature after picking, preferably 32° F. (17).

Bitter rot (*Glomerella cingulata*).—Serious disease in the South. Not serious north of southern Missouri, the Ohio and Potomac Valleys, or west of Missouri and Arkansas. Sometimes causes a limb canker, but chiefly a rapidly developing, juicy rot of the fruit, which appears in hot, moist weather. Spots are at first blisterlike, but soon become typical rots, reaching to the core. Later they are somewhat sunken and have concentric circles of pink to black pimples (spore masses) on their surfaces. Disease lives through winter in cankers and mummied fruits. (See Cankers.)

Control: Spray with Bordeaux at intervals of two weeks throughout the hot season or from eight weeks after the petals have fallen until about one month before the fruit is picked. In the Middle West removal of cankers and mummied fruits is often necessary. (18).

Black rot (*Physalospora malorum*).—Sometimes called "ring rot." Resembles bitter rot and appears at the same time, but is a solid or dry rot, often zoned or ringed, that starts from a crack or wound. Seldom very destructive. (See also Black-Rot Canker and Leaf Spot.)

Control: Regular spraying for other diseases helps to hold it in check. May be controlled by spraying as for bitter rot.

Blotch (*Phyllosticta solitaria*).—Occurs in South Central States and is slowly spreading to the North and East. Only locally severe north of the Ohio Valley and east of the Alleghenies. Affects the fruit, leaves, and twigs. On the fruit the spot or blotch consists of a somewhat circular, brown or black raised spot, often with fringed margins. Later in the season the apple may crack and the spots on picked apples become sunken. On the leaf blades the spots are small and white, but on the petioles they are black and sunken. On the twigs black cankered areas, often with tan-colored centers, are formed. Principal damage is to the fruit.

Control: Spray three or four times with Bordeaux at intervals of three weeks, beginning two weeks after the petals have fallen. (19).

Blue-mold rot (*Pennicillium sp.*).—Found generally and is the most common storage rot. Starts at bruises and skin punctures.

Control: Handle the apples carefully, and cool as rapidly as possible.

Cankers—*General.*—Group of fungous diseases on the bark and wood of the branches and twigs, sometimes extending to the bodies of the trees. Caused by various species of fungi. Most apple cankers grow slowly. Many of them have a tendency to check during the active growth period and overgrow on the margins, and they repeat the process for several years. The more important kinds are given on following pages.

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Anthracnose (*Neofabræa malicorticis*).—Occurs only in the Pacific Northwest, mostly in Washington and Oregon. Sometimes very destructive. A rather rapidly growing canker, which forms elliptical or round spots of dead bark with concentric markings, as it extends. Has a tendency to form elongated strips of dead bark. Frequently girdles large branches, killing the entire top above them. It infects during the fall rains and makes its principal growth during the mild, rainy winters of the Northwest. Spores of this fungus from the old cankers attack the fruit in autumn and often attack the apples in transit and storage.

Bitter-rot canker (*Glomerella cingulata*).—Occurs in humid eastern half of United States from Maryland to Kansas, and southward. Caused by the fungus that produces bitter rot. Forms sunken, usually zonate cankers, which throughout the summer produce the characteristic pink spore masses. More common in the Middle West than in the East.

Black-rot canker (*Physalospora malorum*).—Especially common in the humid eastern half of the United States and is more abundant to the northward. Caused by the same fungus that produces apple leaf spot and black rot of fruit. Forms concentric rings more or less annual, usually resulting in elliptical or elongated sores on the branches. Usually kills deeply, destroying the cambium layer, and may be so rapid as to have little overgrowth, or it may be slow or check up and have an overgrowth at the margin. The same fungus attacks twigs and branches killed with pear blight, or may extend from the base of a blighted twig into the larger branches. Supposed to gain its entrance mostly, if not solely, through wounds and injuries. (See also Black Rot and Leaf Spot.)

Blister canker (*Nummularia discreta*).—Occurs fairly commonly in the eastern United States, from southern New York westward to Nebraska and southward. Not abundant east of the Alleghenies, but is common in the Mississippi Valley. Because of its abundance in southern Illinois it has been known as the Illinois apple canker. Kills the bark in more or less elongated areas. The large fruiting bodies, about three-sixteenths inch in diameter, are dark colored on the upper face, and are arranged in rows parallel to the margin. When they are developing they resemble blisters; hence the name. When the bark ruptures and weathers off, they have a remote resemblance to an eye; hence the name "bird's-eye" fungus has been applied. Extends very rapidly into the bark, kills the cambium, and penetrates deeply into the wood, so that there is rarely any overgrowth on the margin, except in mild cases. Often girdles the entire branch and may even extend into the trunk. The mycelium in the wood may extend into the trunk and be impossible to eradicate.

Blotch (*Phyllosticta solitaria*).—Occurs abundantly in the southern part of the Middle Western States. Occasionally is found in the Eastern States, mainly southward, and not so far north as New York. The apple-blotch fungus forms one of the commonest of the minor cankers.

European apple canker (*Nectria galligena*).—Occurs mostly in the New England States and in New York, Oregon, and Washington. It is a slow-growing canker, forming repeated overgrowths and distinct, usually one-sided swellings on the smaller branches, which are several times the diameter of the branch. Clusters of bright red, flask-shaped fruiting bodies are barely visible to the naked eye, but can be seen readily with a hand lens.

Common in Europe, but usually not abundant enough to be serious in the United States.

Control of cankers.—As a group the fungous apple cankers are controlled successfully by a combination of eradication or cutting out, and fall or dormant spraying. New infections of western anthracnose are prevented by Bordeaux-mixture spraying, preferably the 5–5–50 formula, just before or about the time the fall rains begin, though it is said that this treatment may be made at even an earlier date. It is advisable in all cases to eradicate the canker by the same methods used in controlling pear blight. Remove the cankers from all seriously infected trees by sawing off the branch several inches below, and if possible below the point where the wood shows the stain caused by the penetration of the fungus, and then paint the wound with coal tar thinned with creosote oil. It is safer to burn the canker wood at once, and thus prevent spore emission. The blister canker, on account of its extreme tendency to penetrate the wood, is one of the hardest to eradicate. The minor bark cankers are usually fairly well controlled by the ordinary summer treatment, but in special cases the combination of pruning and fall spraying with Bordeaux mixture may be advisable.

Cedar rust (*Gymnosporangium juniperi-virginianæ*).—This fungus has an alternate generation on the common red cedar. It is a native disease, originally attacking, though not very seriously, the three species of native wild crab of the eastern United States on the one hand and the red cedar on the other. Mainly within the last 15 years it has adjusted itself to the cultivated apple and has become destructive to the foliage and the fruit. It forms orange-yellow, slightly thickened spots on the leaves, and fringed cluster cups on the underside, which give it a rusty appearance. Similar spots also form on the fruit, mostly on and around the calyx. The fungus infects the fruit and foliage of the apple for a period of five or six weeks in spring, beginning at blossoming time. The spots mature, and the fungus forms its spores about two months after the apple blossom. The spores of the apple form transfer at this time to the red cedar. The dormant infection results on the cedar trees and carries over winter without being visible. It grows into galls, in the form of little brown balls varying in size from an inch or more down to a pinhead, during the following growing season. These galls pass the winter in their nearly mature stage on the red cedar, and about the time that the apples come into bloom on the advent of spring rains the galls exude bright, orange-yellow gelatinous spore masses. The spores germinate rapidly and produce minute, wind-borne sporidia which carry the infection to the apple. The fungus has thus spent about three to five months on the apple and the rest of its two-year life cycle on the red cedar. The spores formed on apples can not germinate on the apple, and the red cedar spores can not reproduce on the red cedar. The fungus can live only by going directly from one host to the other.

Control: Eradicate red cedars in the vicinity of the apple orchard. Grub the small trees, and chop the larger ones off at the ground. The work can be done at any time up to the middle of February. Between the middle of February and blossoming time the gall-bearing cedars should be burned at once after being cut down. The spores carry from one-half to 4 miles, but the cedars nearest to the apple trees are the most

important to destroy. Apples vary greatly in their susceptibility, but the adjustment of the disease to different varieties appears to be increasing. Among the more resistant apples are those of the Winesap group. Even these varieties are being attacked in some localities. York Imperial, Wealthy, Rome Beauty, and Jonathan are among the varieties most severely attacked.

Chlorosis and rosette.—Nonparasitic disease which intergrades. Occurs mostly in the irrigated orchards of the Western States, and only occasionally in the humid eastern half of the country. Disease generally associated with an excess of lime or some other calcareous matter in the subsoil, bad drainage, and the presence of hardpan. Chlorosis, sometimes called lime chlorosis, is indicated by the tree turning distinctly yellow, often a bright lemon yellow, which appears more or less uniformly over the whole tree or over certain branches or parts of the tree. Yellow coloration begins to appear in the leaf tissue between the veins, usually leaving the veins and even the veinlets distinctly green or greener than the rest of the leaf. Although much discolored, the leaves are fairly persistent and inclined to remain through the summer, but they fall somewhat prematurely. The rosette type has narrow leaves, sometimes extremely narrow and lanceolate. They are inclined to be acute or acuminate at the apex and to form more or less of a cluster on short internodes that produces a rosette effect. Both types may occur on the same tree or branch, and all intergrades may be found. Like other diseases of the environmental type, they are worldwide in distribution.

Control: Apply humus-forming materials to the soil. Mulch with straw, weeds, or hay. Use stable manure when it is available. Grow cover crops. Manuring and mulching may not have marked effects until a second year, and sometimes may produce no change for three or four years. Alfalfa is generally used in the Pacific Northwest for controlling this group of diseases. The best results have been obtained by growers who did not mow the alfalfa but allowed it to mat down year after year undisturbed.

Crown gall (*Pseudomonas tumefaciens*).—Less abundant and severe in the Northeastern States, more abundant in the South and West, and most abundant and destructive in the Southwest. Forms dark-colored, wartlike, tuberculate, usually hard galls, on the collar and the root system. Makes its attacks in both nursery and orchard. The galls may reach an enormous size that exceeds the diameter of the trunk which they sometimes encircle. They are hard and woody, except the very young galls, which are often soft and light. Some of the galls (woolly-knot type) are covered with abnormal small roots, many of which are fleshy and soft and have a very small, woody fiber in the center. The disease grades off into the " hairy root, " which may be of the soft or branching type. Hairy-root nursery trees, when planted in the orchard, rapidly produce the hard-gall or woolly-knot type. There is a so-called aerial type of crown gall on the branches, the galls being similar and tuberculate, but not definitely proved to be caused by the crown-gall organisms. They may be even more numerous throughout the top of the tree than the root-gall type. The disease is very common in the nursery and often in destructive abundance. The nursery trees when planted in the orchard retain the infection and " root off " more freely than normal, healthy trees. Many become stunted by the extension of the disease, and after a few years in the orchard recognizable " runts " may result. They may carry considerable gall

and be only slightly stunted or apparently outgrow the disease in favored districts and do well through the main life of the orchard.

Control: No treatment has been found satisfactory. When the galls are cut out they come back again from the margins. When pruned off they are apt to reappear at other points. Inspect, after washing roots, all nursery trees before planting. Even a small amount of infection by crown gall or hairy root should render a tree unfit for planting. When well-marked cases are found in orchards up to 3 or 4 years of age it is advisable to dig out and destroy the tree, to remove the earth and small roots from the hole, and to replant with a healthy tree. In older or bearing orchards do the same thing only with runts or obvious failures from this cause. It may not be profitable to remove trees, even though infected, if they are bearing commercially successful crops. Do not propagate by cutting buds or cions from an obviously diseased tree.

Fly speck (*Leptothyrium pomi*).—Usually accompanies "sooty blotch," having the same general distribution. Consists of an aggregation of superficial black specks.

Control: Spray as for the control of sooty blotch.

Leaf spot or frog-eye (*Physalospora malorum*).—Common, circular, brown-spot disease found in the eastern half of the United States. (See also Black Rot and Black-Rot Canker.)

Control: Use the same method as for scab.

Mildew (*Podosphæra leucotricha*).—Occurs in Pacific Coast States. Whitish, powdery appearance of the leaves and sometimes a russet coloring of the fruit.

Control: Use sulphur sprays early in the growing season. The cluster bud and calyx applications are particularly important. Applications are usually necessary two to four weeks after the calyx spray. (20).

Pear blight (*Bacillus amylovorus*).—(See Pear Blight under Pear.) Sometimes called fire blight and twig blight. Apple is not attacked so severely as the pear. In certain seasons it affects certain less-resistant varieties. Outbreaks of the blossom-blight form, which is distributed by insects at times, have been so destructive to the blossom as practically to ruin the crop. The twig-blight form, which follows the blossom blight, is also destructive, killing so much of the bearing wood that the tree will take a year or two to recover its fruiting capacity. Young orchards may be destroyed outright. The most serious point of attack on the apple, as on the pear, is the collar of the tree at the ground line. In the East collar blight is most severe on the Grimes Golden; in the West, from Colorado northward and westward, it attacks the Grimes Golden and Esopus Spitzenburg seriously.

Control: Early cases may be eradicated. Use a carpenter's gouge in detecting the collar blight. Make a shallow cut the size of one's finger nail to show the color. Disinfect the cuts and tools with corrosive sublimate. Paint the wound, or make a bridge graft, if necessary. Plant new orchards by top-working onto resistant sorts. Use stocks of known resistant sorts and of a thrifty and vigorous type. Piece-root graft with a long cion and a small piece root, or better, when practicable, on the tree's own roots. Varieties which so far have given good results are the Winesap group, especially Arkansas (Mammoth Black Twig) and Winesap, the Northwestern Greening, and the Delicious.

Rosette (*nonparasitic*).—See Chlorosis.

Scab (*Venturia inæqualis*).—Most widely distributed of the apple diseases. Serious in all except the irri-

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gated sections of the United States and is particularly destructive in the Northern States east of the one hundredth meridian. Affects the leaves, fruit, blossoms, or blossom buds, and sometimes, in New England, the twigs. The name "scab" aptly describes the brownish patches on the affected parts. On the fruits they are most common on the calyx end. Frequently the fruits are dwarfed, deformed, and cracked. Develops chiefly during the spring and is favored by cool, moist weather. In the Northern States there is often a secondary development in late summer.

Control: Destroy the leaves, since the scab winters on them. The principal and usually sole means of control is to spray with summer-strength lime-sulphur solution when cluster buds have opened or when petals are showing pink, again when petals have fallen, and repeat three weeks later. In the North an additional application in August should be made, and, when time permits, two applications in place of one should be made between the opening of the cluster buds and the opening of the blossoms, the so-called "prepink" and "pink" applications. Except in the North, the three applications as given above are usually sufficient.

Scald.—General during the latter half of the storage season. Browning of green or unblushed side of the apple.

Control: Pack box apples in oiled wraps and barrel apples in shredded oiled paper. Cool as rapidly as possible. (21).

Sooty blotch or cloud (*Glœodes pomigena*).—Common, especially in the moist locations from the Mississippi River eastward. On the mature or nearly mature fruit, a superficial dark or sooty spot, which can be wiped off with a moist cloth.

Control: Use single application of Bordeaux mixture in midsummer.

Pear—*Pear blight* (*Bacillus amylovorus*).—Destructive bacterial disease, which kills the blossoms, twigs, branches, and sometimes the entire tree. Bacteria may enter the young leaf by way of the petiole and midrib, but usually the leaves die as the result of the death of the twig and persist until weathered off. Its greatest destruction comes from the killing of the bark or cambium. Various subnames designate the part attacked, such as blossom blight, fruit blight, twig blight, body blight, collar blight, and root blight. Disease is disseminated by insects, both on the twigs and on the blossoms, as well as on the fruits and other portions. Blossom blight, however, is especially the result of the vists of honeybees and other flower-visiting insects. Varieties like Clapp Favorite and Idaho blight with extreme severity. Bartlett, Anjou, Bosc, and Flemish Beauty varieties are rather susceptible. Seckel, Angouleme, Kieffer, and Beurre Hardy are distinctly resistant. Disease is less serious in the cool northern districts, both East and West, and more serious in the southern sections. Most of the infections in the trees which take place largely in the spring of the year come to a definite stop, dry up at the margin, and die out. In the early stage of the disease a gummy exudate is noticed, consisting of minute drops of various sizes, which at first are milky white, but turn amber colored in a few hours, then brown, and finally reddish brown or nearly black. On the larger branches the exudate may appear in large masses, which flow down the side of the branch, leaving a reddish-brown stain. Collar blight results from the girdling action of cases which attack

the moist, fleshy bark on the collar just below the ground line.

Control: Eradicate the hold-over blight after the fruit is picked and before the blossom time in the spring. Caution is required to do the job thoroughly. May be necessary to remove the entire tree for the benefit of the rest of the orchard. Community action may be necessary where pear trees or orchards are close by. Ordinary pruning saws and a large pair of shears are required, as well as a large, strong knife, and a three-fourths-inch carpenter's gouge, a 2-inch chisel, and some form of scraper. Always cut well below or well beyond the outer margin of infection. Since the disease may extend into the vigorous young wood, it is well to watch the wood as well as the bark. Branches that can readily be spared may be pruned off below the margin. Scars or other diseased areas on the branches or on the body may be scraped completely and trimmed neatly around the margin, and the wood left intact if the branch is not girdled, or especially if less than half girdled. Disinfect all instruments with 1 to 1,000 solution of corrosive sublimate before and after using. May be carried in a clean-stoppered bottle and made by adding one tablet to a pint of water. Tablets may be procured at a drug store. A sponge or a swab of cloth which may be attached to a string fastened to the cloth or attached to the end of a stick, is kept saturated with this solution. After each cut is finished, the fresh wound is saturated thoroughly and the tools are wiped clean with the disinfectant. Paint all wounds and eradication scars with coal tar thinned with creosote oil to the consistency of a slightly thick paint. Gather up and burn the chips, twigs, and branches. Collar blight requires special attention, and when it is prevalent or suspected the orchard should be examined and a slight, shallow cut about one-half inch in diameter made in each suspected tree. This should be just deep enough to take off the brown outer layers of the bark and to expose the color of the inner bark. Do this in dry, sunny weather, and disinfect the healthy exposed parts with the sponge or swab. Collar blight may be handled also by bridge grafting and inarching.

Quince—*Fruit spot* (*Fabræa maculata*).—General. Black spots on fruit.

Control: Give three applications of dilute lime-sulphur or Bordeaux mixture, beginning two or three weeks after the petals have fallen.

Leaf spot (*Fabræa maculata*).—General. Black spots on leaves.

Control: Same as for fruit spot.

Rust (*Gymnosporangium clavipes*).—General. Orange fringelike growth on fruit, and swellings on twigs of the current year.

Control: Remove the cedar trees.

Stone Fruits

Apricot—*Bacterial spot* (*Bacterium pruni*).—Occurs in California. Black spots on leaves, fruit, and twigs.

Control: See Peach.

Blossom blight (*Sclerotinia cinerea*).—Found in California. Death of blossoms and twigs.

Control: Spray with Bordeaux mixture just before and during blossoming period. Remove old diseased twigs and spurs.

Brown rot (*Sclerotinia cinerea*).—General. Known as the common rot.

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Control: Spray with Bordeaux mixture about four weeks before the fruit ripens.

California blight (*Coryneum beijerinckii*).—Occurs in California.

Control: See Peach.

Rust (*Puccinia pruni-spinosæ*).—Epecially in California.

Control: See Plum.

Cherry—*Black knot* (*Plowrightia morbosa*).—General. Affects sour varieties only. Forms hard black excrescences on branches and finally kills branches.

Control: Prune out knots in the fall. Spray with Bordeaux mixture as buds begin to swell.

Brown rot (*Sclerotinia cinerea*).—General. Sweet varieties most susceptible. Known as common rot.

Control: Spray with lime-sulphur solution 1 to 50 about four weeks before fruit ripens. (22), (23).

Leaf spot (*Coccomyces sp.*).—General. Sour varieties most susceptible. Common leaf disease causing spots, shot hole, and yellowing of leaves. Causes defoliation.

Control: Spray with lime-sulphur solution, 1½ to 50 for sour cherries, and 1 to 50 for the sweet varieties. Spray as soon as petals have fallen, then three weeks later, and finally as soon as the fruit is picked. (23).

Peach—*Bacterial spot* (*Bacterium pruni*).—Occurs in the eastern half of the United States, especially southward. Disease also known as bacteriosis and black spot. Spotting and shot hole of leaves, defoliation, spotting and cracking of fruit, and cankers on twigs. Particularly bad on poor soils.

Control: Prune, cultivate, and fertilize to maintain a high state of vigor. (24).

Brown rot (*Sclerotinia cinerea*).—General, except in very dry sections. Common rot of the peach in the orchard, in transit, and on the markets. Also causes a blight of blossoms in hot, moist localities.

Control: Spray with self-boiled lime sulphur or dust with finely ground sulphur about four weeks before the fruit ripens. Control insects, such as the plum curculio, which puncture the fruit. Both curculio and brown rot may be controlled by additional applications as follows: With arsenate of lead as soon as the shucks, or calyces, have been shed from the fruits, and again three weeks later with arsenate of lead and self-boiled lime sulphur. (25), (26).

California peach blight (*Coryneum beijerinckii*).—Occurs in California and locally in the East. Also called gumming disease and pustular spot. Twig cankers with gumming, death of buds, leaf spotting, and shot hole, and spots with whitish centers appear on fruit.

Control: Spray with Bordeaux mixture in November and with Bordeaux mixture or lime-sulphur solution just before the buds open in the spring.

Leaf curl (*Exoascus deformans*).—General. Young leaves and shoots reddened, swollen, and distorted.

Control: Spray with lime-sulphur solution or Bordeaux mixture in fall, winter, or spring, when trees are dormant. One application sufficient. If made in spring, must be done before the buds swell.

Little peach.—See Peach-Yellows Group.

Peach-Yellows Group—*General.*—Under this group may be included the peach yellows, the little-peach disease, and the peach rosette, since they are similar and are controlled by the same methods. The disease is known only in the United States, but its native host, probably some wild stone fruit, is not known. It occurs on Japanese plums. It appeared about 130 years ago, so it probably originated in America. The little-peach disease appeared about 30 years ago, and since it occurs on the Japanese plum may possibly have been im-

ported on this fruit. All three diseases have been reproduced at will by budding, or by grafting in a shield or bark so that the portion of the tissue heals into the tree under test. Inoculations or injections with the juices of diseased trees, crushed tissues, or any other method tried have failed to produce infection.

Peach yellows.—Most widespread and destructive disease of this group. Occurs from North Carolina, Tennessee, and Missouri northward as far as the peach is grown in the northeastern quarter of the United States. Symptoms consist of premature red-spotted fruit, accompanied by bumpings of the flesh, which forms the natural color of the peach, ripening from a few days to a month ahead of time, and a wiry twig growth which may or may not be present on the trees. The twigs are narrow and slender and tend to grow vertically regardless of their position on the tree. Lateral buds often are pushed into excessive growth and make, in extreme cases, a broomlike formation. The leaves on this wiry growth become narrow in varying degrees. The general foliage of the tree at first may be darker green than normal, but it soon assumes a yellowish or sickly appearance. The leaves tend to bend downward and to roll upward from the sides, assuming in well-marked cases a characteristic appearance. Diseased trees begin to die back the second and third years, and by the fourth and fifth years they die outright, root and branch.

Little peach.—Occurs in the northern portion of the peach-yellows district, particularly from Michigan and Ohio to Pennsylvania, Delaware, and New Jersey. Foliage symptoms similar to those of peach yellows. The leaves begin to droop, roll slightly, and turn yellowish from the base of the twigs upward. Rarely produce any abnormal sprouting or other twig symptoms. Its effect on fruit is the opposite of that of peach yellows. Fruit is smaller, often less than half the normal diameter, ripens from a few days to three or four weeks later than normal, and has smaller pits with imperfectly developed kernels. Trees decline and die back from the top like those attacked by yellows. They die completely about the fourth year unless winter-killed previously by severe weather.

Peach rosette.—Southern in its distribution, barely overlapping the southern margin of the peach-yellows region. It occurs in South Carolina, Georgia, Tennessee, Arkansas, Kansas, and Missouri. Attacks more quickly, and pushing of lateral buds is more intense, but instead of elongating they remain very short-branched, frequently producing a number of narrow leaves. As soon as the old leaves drop from the trees a rosette is produced at many of the lateral buds. The whole foliage in the top of the tree then consists of these small, rosettelike clusters from 2 to 4 inches in diameter. Rosette appears on native wild plums, from which source it probably was transferred to the peach.

Peach phony disease.—Occurs in the central and south Georgia peach belt, annually increasing in abundance in the original area around Fort Valley, where it has been known for about 12 years, and increasing in area westward nearly to the State line and northward to Atlanta. Affected trees make a distinctly shorter twig growth; have darker green, larger leaves, with a tendency on account of short internodes to be massed at the ends of the twigs; fruit generally reduced in size and quantity, otherwise normal. The trees do not die, but become dwarfed and commercially worthless; apparently noncommunicable

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and noncontagious, yet the affected area is spreading. No control methods have been developed. This disease is under investigation by United States Peach Disease Laboratory, Fort Valley, Ga.

Control of peach yellows and little peach.—No satisfactory treatment when the tree is once attacked. Manuring, fertilizing, high culture, and other horticultural methods may temporarily stimulate the tree into a better appearance, but the disease proceeds regularly, nevertheless, under all conditions. First, the disease appears on a single tree, and the next year on a colony of two to four or more surrounding it, and new individual cases show up at a distance. The colonies spread and multiply until the whole orchard is rapidly destroyed. Prompt eradication of diseased trees is necessary for control. Inspect entire orchard—tree by tree and row by row—at least three times each season. Make first inspection just ahead of the ripening of the earliest varieties, the second in midsummer, and the third or final inspection just before the foliage begins to ripen or before the earliest frosts. Pull out diseased tree by the roots, allow it to die and dry up, and in the fall remove and burn it. Tree may be chopped up and burned without removing, provided no injury will be caused to other trees close by. Do not drag diseased trees through the orchard. Control other pests which make for sick or yellow peach trees. In well-cared-for orchards, where eradication is done promptly, the annual loss can be kept below 2 per cent.

Rosette.—See Peach-Yellows Group.

Scab (*Cladosporium carpophilum*).—Also called black spot and freckle. Generally distributed, except in very dry sections. Most destructive at high altitudes. Appropriately described by the name "freckle." Spots may coalesce to form a black crust and cause cracking of the fruit.

Control: Spray with self-boiled lime-sulphur, or dust with finely ground sulphur three to four weeks after petals fall. Subsequent applications according to time of ripening. **(25)**, **(26)**.

Plum—*Bacterial spot* (*Bacterium pruni*).—Occurs in eastern half of United States. Most severe in the South. Black spots on fruit and leaves. Shot hole of leaves. Cankers on twigs. Kills trees.

Control: None known.

Black knot (*Plowrightia morbosa*).—General. Very severe on native varieties, but also attacks European varieties. Japanese varieties nearly immune. Swellings and black excrescences on branches and twigs. Kills branches and trees.

Control: Cut out diseased branches in the fall. Spray with Bordeaux mixture as buds swell in the spring.

Brown rot (*Sclerotinia cinerea*).—General. Common rot of the plum in orchards, in transit, and on the market.

Control: Spray when petals have fallen, again two to three weeks later, and finally one month before ripening. Use Bordeaux mixture or dilute lime-sulphur solution on European and most native varieties. On Japanese varieties and hybrids, use self-boiled lime-sulphur with a sticker, such as calcium caseinate. May also be controlled by being dusted with finely ground sulphur. Control curculio by adding arsenate of lead in first two applications.

Pockets (*Exoascus pruni*).—Found especially in the Middle West. Native varieties most susceptible. Distorts leaves and fruit early in season.

Control: Spray with lime-sulphur solution 1 to 50, just before the fruit buds open.

Rust (*Puccinia pruni-spinosæ*).—General. Most severe in the Middle West. Brownish pustules on underside of leaves. Found on European and native varieties.

Control: Spray in June with Bordeaux mixture of dilute lime-sulphur.

Miscellaneous—*Die-back.*—General. Dying of the tips of the youngest branches. Commonly caused by low temperature in winter.

Control: Damage is least on trees not fertilized or cultivated late in the season.

Gummosis.—General. Flow of gum from trunk and branches. May be caused by brown rot, heavy soil, poorly drained soil, winter injury, fungi, bacteria, or other things unfavorable to the trees.

Control: If possible, find the cause, and remove it or lessen its activity. Control is usually impracticable on account of the cause being unknown. Danger of winter injury is lessened if trees are not cultivated or fertilized late in the season.

Small Fruits

Blackberry—*Anthracnose* (*Plectodiscella veneta*).—Distribution general. Light-gray spots with purple borders on canes; rusty-brown spots on leaf and fruit stalks; berries discolored, scabby, and dwarfed, and may dry up before maturity.

Control: Give three or four applications of Bordeaux mixture (4–4–50), the first as a delayed dormant spray.

Cane rust (*Kuehneola uredinis*).—Distribution general. Golden-yellow pustules break out on the fruiting canes, and small rust spots appear on leaves in spring and during the summer. Should be distinguished from orange rust, which is perennial.

Control: Cut out and destroy canes that are badly infected, and apply sulphur dust for leaf infection. Do not uproot infected plants as is done with plants infected with orange rust.

Crown gall (*Bacterium tumefaciens*).—Distribution general, especially on sandy soil. Corky galls up to one-half inch or more in diameter on canes, roots, and root crowns.

Control: Plant disease-free nursery stock. Cut out diseased canes, and practice clean cultivation and rotation.

Double blossom (*Fusarium rubi*).—Occurs from New Jersey to Ohio and southward. Dense masses of small spindling shoots and leaves at infected nodes in form of witch's brooms. Blossoms wrinkled, somewhat enlarged, and not setting fruit.

Control: Pick off and destroy the abnormal growths as soon as they appear in the spring, if possible before the blossoms open, to prevent spreading of the fungus spores.

Leaf spot (*Mycosphærella rubi, Plectodiscella veneta*).—Distribution general. Small gray spots that often have purple margins or have minute black specks in the center.

Control: In severe cases use Bordeaux mixture as for anthracnose.

Orange rust (*Gymnoconia interstitialis, Cæoma nitens*).—Distribution general on wild and cultivated blackberries. Perennial systemic disease, causing excessive sprouting from crowns and spindling canes, which do not blossom. Small, yellowish-green leaves; orange-colored pustules break out on the underside about blossom time.

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Control: Inspect new plantings as soon as the first leaves are well out. Uproot and destroy infected plants as soon as they appear in the spring. Clear out wild brambles in the near-by hedgerows.

Currant—*Cane blight* (*Botryosphæria ribis*).—Severe in New Jersey, and during certain seasons, in the Hudson Valley, N. Y. Readily recognized from the dead, upright canes. Canes may die at any time during the growing season, but death occurs most frequently about the time the fruit is ripening.

Control: No satisfactory control has been developed.

Leaf spot (*Septoria ribis*).—Found wherever currants are grown. Characterized by small, irregular spots, having pale center and brownish-purple margins on the surface of the leaves. Minute, dark-brown pustules of the fungus produced on the undersides of the spots.

Control: Easily controlled by a spraying with Bordeaux mixture. (27).

Rust.—See White-Pine Blister Rust.

Cranberry—*Bitter rot* (*Glomerella cingulata vaccinii*).—General with the crop. Pale yellowish-brown discoloration and softening of the fruit.

Control: Make four applications of Bordeaux mixture.

Early rot (*Guignardia vaccinii*).—General with the crop. Found in New Jersey particularly. Blackens blossoms and young fruit and causes pale, soft rot of berries; also packs leaves.

Control: Bordeaux mixture with sticker; at least four applications.

End rot (*Fusicoccum putrefaciens*).—Common wherever crop is grown. Soft, pale rot, usually beginning at blossom end, sometimes stem end. Develops late in the season and during picking and transportation.

Control: Spray with Bordeaux mixture. Handle fruit carefully, and keep it cool.

False blossom.—Widely distributed, but worst in Wisconsin. Causes witch's brooms and abnormal development of flowers, which do not set fruit. Apparently infectious.

Control: No satisfactory control known. Set only healthy plants. Dig up and destroy all diseased plants.

Rose blossom (*Exobasidium oxycocci*).—Occurs widely in Massachusetts and on the Pacific coast. Axillary buds develop abnormally, producing swollen rose-colored clouded leaves somewhat resembling a flower.

Control: Keep bogs as dry as practicable. Avoid late holding and reflowing.

Gooseberry—*Leaf spot.*—See Currant.

Powdery mildew (*Sphærotheca mors-uvæ*).—Most serious on European varieties or on hybrids with European varieties. Usually not severe on American gooseberries. Disease is recognized from the white, cobwebby growth on the leaves and fruit, which gives them a dusty appearance.

Control: Spray with commercial lime-sulphur, 1½ gallons to 50 gallons of water. Make three or four applications, beginning as soon as the leaf buds open. (27).

Rust.—See White-Pine Blister Rust.

Raspberry—*Anthracnose* (*Plectodiscella veneta*).—See Anthracnose of blackberry and dewberry.

Control: Use lime-sulphur, 1 to 10, or Bordeaux mixture (4–4–50), with calcium caseinate or gelatine sticker, applied as a delayed dormant spray, or when the leaves just begin to show green. In the most serious cases a second application of Bordeaux (4–4–50) may be advisable. Then spray not later than a week before the blossoms are open, and only the young canes. Avoid spraying leaves of old canes.

Cane blight (*Leptosphæria coniothyrium*).—Distribution general but appearance sporadic. Certain varieties are rather resistant. Whole canes or single branches begin to wilt and die down. Light-colored patches on the bark, later becoming smutty because of masses of spores. Wood strongly colored and brittle where diseased.

Control: Use Bordeaux mixture (4–4–50) or lime-sulphur (1 to 10) as a dormant spray. Cut out badly diseased vines, and practice clean cultivation.

Crown gall.—See Blackberry.

Leaf curl.—Occurs in New York, Ohio, and on the Pacific coast. Cause is unknown. Systemic disease spread by aphids, finally dwarfing the canes which develop an inferior dry fruit. Leaves small, arched, and wrinkled, margins curled inward.

Control: Uproot infected plants, and burn them before they wilt to prevent migration of the aphids to healthy plants.

Mosaic (*a virus disease*).—Distribution general; certain varieties of raspberry rather resistant. Cause is unknown. Systemic perennial disease spread by aphids. Plants gradually decline or become dwarfed and produce only inferior fruit. In cool weather leaves on growing shoots are mottled, or have blisterlike patches of dark-green and yellow areas. Leaves on plants long infected become smaller and more deeply cut or notched.

Control: Rogue out all infected plants and burn them before they wilt to prevent migration of the aphids to healthy plants.

Orange rust (*Gymnoconia interstitialis*).—(See Blackberry.) Distribution general where black or purple varieties are grown. Not found on red raspberries. Differs from the common orange rust of blackberries in developing a teleuto stage, the spores of which mature in summer and cause infection of rooting tips of the canes. Such infected plants never bear fruit, the canes being weak and spindling. Young basal roots, which develop from crowns of old plants in summer, occasionally become infected so that only a part of the canes in such a hill will show rust.

Control: Inspect new plantings as soon as the leaves are well out, and uproot and destroy the plants showing rust. New plants may be set out in place of them. Later, as the orange rust may show in old plants, cut out that part of the crown from which the rusted canes are developing, if it is desired to save the rest of the hill.

Spur blight (*Mycosphærella rubina*).—Distribution general on red raspberries, but appearance sporadic. Brown spots on leafstalks, the region around the bud turns brown, leaf blades fall off, and canes dry out and crack.

Control: Prune out old canes after harvest. Apply Bordeaux mixture as for cane blight, spraying only the young ones.

Streak.—Distribution on black raspberries, New York to Ohio and Pacific coast. Perennial systemic disease; cause unknown. Plants stunted, leaves curled and mottled. Dark-blue streaks along the canes.

Control: Same as for leaf curl.

Strawberry—*Brown fruit rots* (*Botrytis cinerea, Pezizella lythri, Phytophthora cactorum, and Rhizoctonia sp.*).—Common in the large strawberry sections. Most field rots of strawberries fall in this class, which may be recognized by the characteristic brown color.

Control: Mulch and keep surface of the ground as dry as possible by proper drainage. Cull out any berries affected with any of the rots at the time they are picked and packed.

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Leak (*Rhizopus nigricans*).—Common in transit and on the market, especially when strawberries have been shipped long distances. Characterized by the collapse of the berries with the loss of much juice.

Control: Handle carefully to avoid bruising the berries. Refrigerate as soon as possible after picking. (28), (29).

Leaf spot (*Mycosphærella fragariæ, Mollisia earliana*).—Found wherever strawberries are cultivated. Causes, on the leaves, dead spots, which may enlarge and grow together so that the whole leaf becomes purplish or reddish.

Control: Make frequent renewal of strawberry patches. Control severe infections by spraying with Bordeaux mixture (4–4–50).

Mildew (*Sphærotheca humuli*).—Occasionally serious in the eastern United States. White, cobwebby growth on under side of leaves. Edges of leaflets curl upward.

Control: Dust with 85–15 lime-copper dust.

Nematode gall (*Tylenchus dipsaci*).—Found in Washington and Oregon. Plants become dwarfed and take on a lighter green color than normal plants. On leaf and fruit stems are often found conspicuous galls which contain nematodes in great numbers.

Control: Avoid planting strawberries that are infected or that come from infected fields. (30).

Root knot (*Heterodera radicicola*).—Common throughout the Southern States. Characterized by swellings or enlargements of the roots.

Control: Plant on new land or land known to be free from root-knot nematode. Affected fields may be freed of nematodes by three-year rotation with crops that are immune to the root-knot nematode. (31).

Yellows (*a virus disease*).—Found in California and Oregon. Dwarfing and curling or cupping of leaves and yellowing around their margins and between the larger veins. Disease is carried from infected plants to healthy plants by a strawberry aphid. New plants cut from runners of diseased plants will show the yellows.

Blueberry—*Mummy berry* (*Sclerotinia sp.*).—Found wherever blueberries are cultivated. Readily distinguished by the fact that the fungus fills the cavity of the berry, with the result that the fruit becomes a true mummy.

Control: Bury the mummies that lie on the ground by cultivating before the plants blossom.

Twig blight (*Phomopsis sp.*).—Occurs in Massachusetts and New Jersey. Characterized by dying of the younger branches or in severe cases whole uprights or bushes.

Control: Proper drainage. Cut out dead twigs or bushes.

Witch's broom (*Calyptopsora gœppertiana*).—Found on both low and high bush blueberries in New England and eastern Canada. Disease forms a large witch's broom and sometimes results in the death of the bush.

Dewberry—*Anthracnose* (*Plectodiscella veneta*).—Distribution general on cultivated dewberries. Gray spots with purple margins on canes. Scabby spots on green parts of the fruiting branches and on green fruit, which will remain undersized and fail to ripen normally.

Control: For North Carolina and southward, cut off close to the ground and destroy all vines, both new growth and old, after the berries have been picked. Apply Bordeaux (4–4–50) in August or when the new growth is 1½ to 2 feet long, next as a dormant spray after vines have been tied up, and finally after the fruit has set or has become a third grown. In the northern regions cut away the old vines after harvest. Make three applications of Bordeaux, beginning with the dormant spray in the spring.

Double blossom (*Fusarium rubi*).—Common on Lucretia dewberry in New Jersey and southward. (See Double Blossom of Blackberry.)

Control: Cutting off all the vines close to the ground after the fruit has been picked controls the disease effectively in North Carolina and southward. In New Jersey, Ohio, and northward the vines can not be cut away. Pick off the witch's broom by hand and burn as for double blossom of blackberry.

Leaf blight (*Cercospora rubi*).—Occurs from North Carolina and Georgia to Texas. Brown spots from the size of a pinhead to half an inch across. Badly infected leaves dry up and fall off.

Control: Use Bordeaux mixture same as for anthracnose.

Leaf spot.—See Blackberry.

Grapes

Anthracnose (*Sphaceloma ampelinum*).—Occurs in eastern United States and southward especially. Erratic disease. Characterized by minute, irregular, brownish spots on leaves; sunken, oblong, grayish cankers with reddish border on stems; and similar cankers on the green fruit.

Control: Cut out and burn diseased branches. Spray with lime-sulphur (1 to 9) dormant and with four applications of Bordeaux mixture during growing season.

Bitter rot (*Melanconium fuligineum*).—Occurs in eastern United States and most frequently in the South. Causes dark-colored, soft rot of fruit.

Control: Make four applications of Bordeaux mixture.

Black rot (*Guignardia bidwellii*).—Found everywhere east of Rocky Mountains, but does most damage in the South. Causes leaf spot, cankers on shoots, and rot of fruit. Rot at first light colored, soon becoming dark, and berries mummied, covered with minute black pustules.

Control: Spray with Bordeaux mixture. (32).

Dead arm (*Cryptosporella viticola*).—Frequents eastern United States, especially North. Elongated cankers on main branches, frequently girdling them.

Control: Remove and burn cankered branches. Spray with Bordeaux mixture and lime-sulphur.

Downy mildew (*Plasmopara viticola*).—Occurs east of Rocky Mountains. Common disease. Thin, loose, downy growth on underside of leaves, causing brown areas on the upper surface; also attacks the young grapes.

Control: Rake and destroy the diseased leaves. Spray with Bordeaux mixture, especially the under side of leaves.

Powdery mildew (*Uncinula necator*).—Occurs throughout the United States, but is worst in California. Thin, white, powdery growth on the surface of the leaves causing them finally to become brown; also attacks shoots and fruits, producing brownish spots and preventing normal growth.

Control: For the eastern United States, use Bordeaux mixture. For the Vinifera grapes on Pacific coast and in the Southwest, dust with very fine sulphur when new shoots are 6 or 8 inches long and while the vine is in bloom.

Ripe rot (*Glomerella cingulata*).—Occurs east of the Rocky Mountains, especially in wet, hot seasons. Causes soft, light-colored rot of fruit late in season.

Control: Spray with Bordeaux mixture.

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Rust (*Physopella vitis*).—Common in Florida. Minute, yellowish powdery pustules on under surface of leaves, causing brownish areas and defoliation.

Control: No remedy known. Sulphur dusting may be effective at times.

Subtropical Fruits

Grapefruit (8)—*Blue-mold rot.*—See Orange.

Citrus canker.—See Orange.

Die-back.—See Orange.

Foot rot.—See Orange.

Melanose.—See Orange.

Mottled leaf.—See Orange.

Scab (*Cladosporium citri*).—Occurs in Florida and the humid portions of the Gulf region. Affects fruit and leaves at young stages. Irregular, warty outgrowths are produced that have light-brown or grayish tips. These may run together, and, with the enlargement of the fruit, may flatten down almost to the normal surface level.

Control: Under conditions very favorable for development, make one to three applications of Bordeaux (3–3–50). Important to coat the very young fruit as soon as enough petals have fallen to expose a good setting. In rainy weather a second application should follow in two weeks. A clean-up application is helpful to cover hold-over lesions on old leaves before the spring flush starts. Lime-sulphur (1 to 40) solution is not so effective, but may give satisfactory results in mild outbreaks. Follow the Bordeaux with an application of oil emulsion in June to control scale insects. (33), (34).

Lemon (8)—*Black rot* (*Alternaria citri*).—Occurs in California. Similar in many ways to orange black rot, but infection is not always at the blossom end.

Control: No definite method of control.

Blast and black rot.—See Orange.

Blue-mold rot.—See Orange.

Gummosis.—See Orange.

Internal decline.—Occurs in California. Nonparasitic disease. Premature ripening, beginning at the blossom end. Interior shows discolored streaks in inner peel or core.

Control: No definite measures have been worked out.

Scab.—See Orange.

Brown rot (*Pythiacystis citrophthora*).—Occurs in California. Firm, brownish rot of the fruit. The causal organism lives in clay soils. The spores are spotted over fruit and lower limbs.

Control: Spray with Bordeaux mixture during winter rainy period, coating lower limbs and surface of soil under trees. Wash the fruit in water at 115° to 120° F. Use bluestone in the wash water at the rate of 1½ pounds per 1,000 gallons to control the rot.

Orange (8)—*Blast and black pit* (*Pseudomonas citriputeale*).—Occurs in California. Watery deterioration of leaves and petioles extending in shield-shaped areas onto the twig at the base of the leaf. Leaves dry in place and hang on. Twigs die. Fruits develop dark, sunken spots that do not decay.

Control: Promote slow, compact growth of trees, and avoid pruning. Spray with Bordeaux mixture during rainy weather from October to December. (35).

Blossom end rot (*Alternaria citri*).—Found in Florida and California. Sometimes caused by other fungi. Slow, dry, black rot at the blossom end of the fruit, extending deep into the pulp tissue. Infection may follow blossom-end splitting owing to physiological causes, or may take place through the irregularities of a naval development while the fruit is growing.

Control: No satisfactory method of control has been worked out. Cultural and soil-improvement methods that tend to lessen extreme fluctuations in water supply may have a beneficial effect. (36).

Blue-mold rot (*Penicillium digitatum, P. italicum*).—Found in all citrus regions. Very soft, watery rot of the mature fruit, starting at a wound and quickly developing a white mycelial growth with abundant, dusty coating of either olive-green or blue-green spores.

Control: Exercise extreme care at every stage of handling to avoid bruises and breaks that may open the way for infection. Soaking the fruit for five minutes in a 5 per cent borax solution at 120° F. and allowing the borax to remain after drying will control blue-mold rot. Dipping the fruit in 5 per cent borax solution at ordinary temperature and allowing it to dry will prevent more than half of the blue-mold infection. (37), (38), (39).

Brown rot.—See Lemon.

Citrus canker (*Pseudomonas citri*).—Introduced into the citrus sections of the Gulf States. Now practically eradicated from all important citrus areas. Leaves, fruit, and twigs are infected at an early growing stage. Brown, corky spots, having yellowish-green, water-soaked borders, extend entirely through the leaf tissues, or rather deeply into bark or peel.

Control: Make careful and frequent inspection to detect first appearance of the disease. Destroy every infected plant. Enforce strict quarantine regulations. (40).

Die-back.—Common in Florida and occasionally found elsewhere. Nonparasitic disease. Main symptoms are multiple buds, stained terminal branches, bark excrescences, gum pockets, and ammoniated fruit. Such fruit shows dark-brown to black spots of variable size that are slightly elevated, have a somewhat greasy feel, and show a tendency to form irregular fissures. Usually die-back can be associated with some unfavorable conditions of growth, such as overfeeding or unbalanced fertilization, poor drainage, or excessive cultivation.

Control: Correct unfavorable conditions. Reduce cultivation and ammonia content of fertilizer. Apply pulverized bluestone to the soil, like fertilizer, at the rate of 1 to 2 pounds per each 10-year-old tree, preferably in the fall of the year. Applications of Bordeaux mixture have a good effect. (40).

Foot rot (*Pythiacystis citrophthora, Phytophthora terrestria*).—Occurs in Florida and California. Disease attributed to these fungi. Bark rots on the lower trunk and larger roots, especially of sweet orange.

Control: Remove soil thoroughly so as to expose all large roots for 18 inches from the trunk. Thoroughly cut out all diseased bark. Paint with a good antiseptic, such as Bordeaux paste. Leave the roots bare until protection from cold is needed. Inarching with resistant sour-orange stock is sometimes practiced. (40), (41).

Gummosis.—Attributed to various fungi. Several types of gummosis are recognized in California and Florida. Common symptom is the death of the bark on trunk limbs and formation of more or less gummy exudate.

Control: Examine trees periodically so as to detect the disease in early stages. Cut out the affected bark and paint with Bordeaux paste or other good antiseptic. See that the tree has favorable growing conditions.

Melanose (*Phomopsis citri*).—Occurs chiefly in Florida and slightly elsewhere. Minute, raised, rough, mahogany-brown spots with surrounding narrow zone of scar tissue. These do not penetrate below the surface. Fruit feels like sandpaper. When very numerous, the spots may

coalesce to form rough areas with mud-cake cracks. Tear-streak or circular line patterns are common. Leaves, fruit, and twigs are affected in young stages.

Control: Spray very young fruit with Bordeaux mixture (3–3–50), plus 1 per cent oil emulsion. Under Florida conditions one application made late in April gives satisfactory control. A special application of oil emulsion must be made in late June to keep down increase of scale insects after destruction of entomogenous fungi by the Bordeaux mixture. **(42)**, **(43)**.

Mottled leaf.—Occurs in Florida and California. Nonparasitic disease, sometimes called frenching and chlorosis. Mottled leaf or frenching refers to a yellowing of leaf areas between the main lateral veins. Chlorosis is a yellowing that extends rather uniformly over the whole leaf. The former may be a symptom of die-back, or of so-called withertip, or may develop independently of these two troubles, but usually can be traced to some unfavorable soil conditions. Applications of lime often cause it. Chlorosis may be an extreme development of mottled leaf, or may develop without producing the mottled pattern on the fruit. In the latter case it is often a sign of insufficient food supply.

Control: Correct any unfavorable condition by giving careful attention to all details of culture. A proper supply of humus material in the form of green manure or stable manure is usually a direct corrective. **(40)**, **(44)**.

Psorosis.—Occurs in California and Florida. Cause is unknown. Outer bark dies and becomes rough and scaly. Gumming is not always prominent.

Control: Scrape away the loose, dead bark and paint with Bordeaux paste. Cut out branches that are badly affected. Watch closely for incipient cases. **(40)**, **(41)**.

Scab (*Cladosporium citri*).—Occurs in Florida and the moister portions of the Gulf region. Round oranges are practically immune, but Satsuma oranges and certain others of the mandarin group are susceptible.

Control: See Grapefruit.

Scaly-bark and nailhead rust (*Cladosporium herbarum*).—Occurs in Florida. Attributed to this fungus and practically confined to the orange. Begins on mature twigs as rather smooth, raised, light-brown spots, reaching one-half inch in size. Later the bark is rough and scales off. On the fruit sunken brown spots may develop about one-fourth inch in size, and sometimes a circular depression with a raised center.

Control: Remove badly affected parts. Use good general orchard care. Quarantine is enforced against shipments from scaly-bark territory. **(40)**.

Sooty mold (*Capnodium citricolum*).—Found in Florida and California. Black surface growth of fungous mycelium in the honeydew excretions of white flies and scale insects.

Control: Control of insects mentioned does away with sooty mold. Use of fungicides not necessary. **(40)**.

Stem-end rot (*Phomopsis citri, Diplodia natalensis*).—Occurs in Florida and slightly elsewhere. Moderately soft, light to dark brown rot beginning at the stem end, and without surface growth of mycelium. Infection occurs in the orchard, the source being dead twigs in which the two causal fungi live and sporulate. Place of entrance is the stem button.

Control: Removing dead twigs partially controls, as does spraying for melanose control. Disbuttoning during the precoloring process is very effective in preventing stem-end rot. Borax solution, 5 per cent, either hot or cold, as for blue-mold control, prevents about three-fourths of the stem-end rot. **(42)**.

Withertip (*Colletotrichum glœosporioides*).—Occurs in Florida and California. Attributed to this fungus. Terminal twigs die and turn light brown to grayish. Usually this condition is caused primarily by unfavorable soil conditions or improper cultural operations. The fungus is a weak parasite and is usually a secondary factor. Leaf spotting and brown fruit spots (anthracnose) have also been attributed to this fungus. The ordinary type of tear stain has been proved to be a form of rust-mite injury. Withertip of citrus must not be confused with the very actively parasitic withertip of limes (*Glœosporium limetticolum*).

Control: Correction of unfavorable conditions usually results in recovery. Prune out the dead portions. Spraying with a fungicide or an insecticide may be helpful under certain conditions. **(40), (45).**

Pineapple—*Black rot* (*Thielaviopsis paradoxa*).—Found in Florida. Dark-colored, soft rot of the mature fruit, usually developing in transit, and starting frequently from the cut stem or a bruised area.

Control: Careful handling and packing, prompt shipment, and proper ventilation and lowering of temperature.

Red wilt (*Heterodera radicicola*).—Occurs in Florida. Leaves assume a reddish tinge and die from the tips. Plants may present a wilted appearance. Roots are dead and decay rapidly. In early stages the slight enlargements caused by the nematodes may be seen.

Control: Keep the land for one to three years in natal grass or some other cover crop that will starve out the nematodes and replenish the humus content of the soil. Use only vigorous, thrifty pineapple slips for planting.

Nuts

General.—Cultivated nut-bearing trees and shrubs grown in orchards and gardens are subject to a number of diseases. These sometimes are the same as or similar to those of cultivated orchard fruits, but often are similar to or identical with the diseases of these same trees in the forest. Therefore, control measures and treatment are more uniformly like those of the orchard.

Almond.—Related to the peach, apricot, and other stone fruits, and is affected by some of the same diseases as the peach and the apricot. More resistant to root rot in California than is the peach. Earliest to bloom of any of the stone fruits, and though the blossoms are somewhat resistant to cold, they frequently are injured, and fruit setting is stopped by frost.

Chestnut—*Blight* (*Endothia parasitica*).—Commonest and most destructive disease of the chestnut. Forms bark cankers on the twigs, branches, and trunk, and girdles and kills the tree. Pink spore masses arranged in more or less concentric rings are a characteristic symptom.

Control: Combating the disease on the American sweet chestnut and on the European cultivated sorts is hopeless. The Japanese species is considerably resistant. By planting these Japanese varieties and by using the methods of eradication prescribed for pear blight, growers are producing chestnuts to some extent in the areas where native chestnuts have been destroyed by this disease.

Filbert (Hazelnut)—*Blight* (*Cryptosporella anomala*).—Attacks the twigs and branches. Cankers contain black fruiting bodies and somewhat resemble the black knot of the plum and cherry, to which they are related. Disease girdles the stems and sometimes is so severe as to kill

or ruin the filbert bushes. Generally severe wherever filberts are grown in the eastern United States. Occurs, to a very limited extent, on the eastern wild hazelnut.

Control: Eradicate by cutting out the diseased canes below point of infection and burning them. Use dormant spray with strong Bordeaux mixture, perhaps followed by two or three summer treatments with the same fungicide. This treatment is not well established, but is reported to be successful.

Pecan—*Scab* (*Fusicladium effusum*).—Attacks the twigs and nuts, forming brownish scabs, destroying the outer shell, and causing the nuts to shrivel and die or not to fill.

Control: Grow resistant varieties and spray. Select the more resistant sorts in planting new orchards, and if possible, top-work susceptible sorts to scab-resistant sorts. Spray with Bordeaux mixture (3–3–50), according to susceptibility of the variety and the amount of rainy weather. Make three to five applications. The first spraying should be made soon after the nuts are formed, and in severe cases the last spraying may have to be as late as the 1st of September.

Rosette.—Physiological disease due to unsatisfactory soil conditions. Causes narrowing and bunching of the leaves, the formation of an extra number of twigs and the dying back of the twigs and branches, so that in extreme cases the tree is rendered commercially worthless.

Control: Disease is aggravated or increased by most fertilizers, by lime, and by clean cultivation. On fairly good soils it is remedied or mitigated by the addition of humus-forming material. Stable manure, mulching with straw or woods trash, or the growth of cover crops will give beneficial effects, although slow and often taking several years. Where the soils are too bad it may not be successful. (46).

Winter injury.—Though the pecan is a hardy, native tree, young trees under 9 years in cultivated orchards of the Southern States are often killed or severely damaged by winter injury on the trunks and collars of the trees.

Control: Avoid late cultivation and fertilization, especially overfertilization. Grow cover crops from midsummer to fall, in order to check the growth of trees and to give mechanical protection. Protect the trunks with burlap, paper, cornstalks, or a similar substance, but remove it in the spring. (46).

Persian (English) Walnut—*Rosette.*—Resembles pecan rosette and probably may be remedied in the same way.

Winter injury.—Though apparently as hardy as the peach, it is often winter-injured on the trunk and body in the Southern States in the same manner as the pecan but more severely.

Control: See Pecan.

Blight (*Bacterium juglandis*).—Common in California, but generally distributed both East and West. Sometimes called bacteriosis. Causes black spots filled with bacteria to appear on the fruit, and destroys and shrivels the young nuts or even those nearly mature. Forms similar spots on the twigs and kills back the twig tips.

Control: No satisfactory remedy.

SUGAR PLANTS

Sugar Beet—*Curly top.*—Occurs only in the semiarid regions of the Western States. Cause is undetermined. Occasions greater loss than any other beet disease. Minute swellings on the underside of the veins of the leaves, which may be prolonged into slender papillæ; and "clearing" of the small veinlets or disappearance of the chlorophyll, so that when leaf is held between the eye and the source of light, the veinlets appear translucent. Edges of leaves are later rolled or incurved and tops badly stunted. Because of phloem necrosis the concentric rings of vascular bundles, as seen in a cross section of the whole beet, are discolored. One of the so-called virus diseases, and is transmitted from diseased to healthy plants by the sugar-beet leaf hopper.

Control: Early planting usually prevents much of the injury. (48).

Leaf spot (*Cercospora beticola, Sacc.*).—Usually does not appear until midsummer, but may be seen any time after the beets are a few weeks old until the approach of fall. First appears as a very small spot, nearly white, which increases in size and assumes a brownish color. The small, brown, nearly round spots are easily seen and are the first symptoms of the disease. Attacks the outer leaves first. Youngest center leaves rarely show the brownish spots. Spots increase in size and show, almost from the first, a distinct line between them and the green surface of the leaf. Margin of spot frequently is tinged with reddish brown or purple. As spots grow older they assume an ashy-gray color. The older leaves die off, and new ones are found at the center of the crown. A badly infected beet shows an elongated crown that has a tuft of green leaves at the top or center surrounded by a large whorl or a number of small whorls of brown, dead leaves.

Control: Deep fall plowing and crop rotation.

Wilt (*Heterodera schachtii, Schmidt*).—Caused by nematodes. Attack appears in restricted areas and sharply defined spots in the beet field or may extend over entire field. In badly infested beets the symptoms may appear as early as the first of June, and under conditions favorable for the nematodes the plants may die before the end of the month. Toward the end of July or early August spots may be noted where the beet foliage has assumed a lighter tint than is normal. Leaves drop until they lie prone on the ground. Outer leaves become yellowish, spotted, and generally discolored, then wilt and die. Inner leaves fail to attain normal size, and when the plant is severely attacked they also die. At this stage the beet may blacken and rot because of a bacterial or fungous invasion owing to the weakened condition of the beet and not caused directly by the nematodes. Sometimes beets recover and develop new leaves but do not attain normal size. Usually are curled and distorted and assume a dark-green color. Affected beets form an abnormally large number of lateral rootlets, which make a double mass called "hunger roots," "bearded roots," or "hairy roots." Numerous adult female nematodes may be observed on the fine rootlets in the shape of protruding white beads. Occasionally small swellings may be seen on the rootlets. Nematodes are no longer to be found on the roots during the last stage of the disease.

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Control: Dispose of dump dirt where it will not be scattered. Use rotation system with no more than two successive beet crops.

Maple.—See Forest and Shade Trees.

Sugar Cane—*Mosaic* (*a virus disease*).—Affected plants are pale green, owing to the light-colored streaks or spots on leaves. Light areas or mosaic patterns are readily noticed on young leaves. In early stage the amount of normal green tissues exceeds that of the light tissues. Light areas are of attenuated streaks, about one-eighth inch wide by 1½ inches long, the size varying greatly. Some streaks are minute, but others may run together and be several inches long. In older leaves the light-colored areas become predominant and the whole leaf pallid or even yellow. Dark-green or normal areas are now very scant, appearing as elongated streaks in the pale green. The plants of plant cane are somewhat stunted, the first-year stubble plants are very much stunted, and many stools may be missing. Stubble crop may be much lighter green, and the internodes may be spindle-shaped and attenuated. Amount of injury depends on the variety, and all gradations from very susceptible to tolerance and to immunity are found. Disease is spread from plant to plant by *Aphis maidis*, and since mosaic is common in corn, sorgo, and wild grasses it may be spread from one to another.

Control: Use varieties which are immune to this disease or which tolerate it without suffering severe injury. (49), (50).

Red rot (*Colletotrichum falcatum, Went*).—Of great economic importance on account of damage done to seed cane. Infected stalks germinate very poorly. Large quantities of seed cane are then required in order to obtain a good stand. Disease is confined largely to the inside of the stalk. Not readily recognized in standing cane. Affected stalks that are split open show red areas marked transversely with elongated spots. White spots indicate the presence of red rot. Fungus enters through wounds, such as borer holes, root buds at the nodes, and through the cut ends of seed cane.

Control: Use seed cane free from red rot. Cut off portions of seed cane that are infected.

Root rot (*Marasmius, Pythium, Rhizoctonia*) (*a snail, Zonitoides arboreus, Say*).—Affected plants grow slowly, often have a yellow color, and usually stool poorly in the early part of the season. May, however, show considerable suckering in the fall. Roots show dead areas or may be so badly rotted that the whole stool can be readily pulled up. In very severe cases there may be a discoloration and rotting of the growing bud, and the lower sheath leaves may be cemented together by a white mycelium.

Control: Plant varieties such as P. O. J. 234 and Cayana that have vigorous root systems, which are less injured than the common varieties.

Sorgo—*Head smut* (*Sorosporium reilianum*).—Parasite of head smut does not always develop a sorus or an infected culm, but frequently causes a floral sterility, which develops a peculiar proliferation of the panicle. Distributed by the wind in the locality in which it occurs. Infects the seedlings from the soil and the growing points of more mature plants. Usually sori and an abundance of spores are produced. When the sori are mature they appear as black, dusty pustules or masses. In extreme cases the ovary and stamens entirely disappear, and growth takes the form of a complete individuation in the place of each flower, a tiny culm

with leaves, nodes, and rudimentary panicle shoots up from the head. Along with the floral changes occurs an abnormal tendency to branch. Lateral buds develop and usually bear sori. Although perfect sori of the parasite are not produced in every head of a plant, most of the stools and branches are affected.

Control: Do not plant on land previously infected. Replant on leeward side of old field with respect to the prevailing winds.

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VEGETABLES

Root and Tuber Crops

Potato—*Blackheart and asphyxiation (physiological)*.—May occur wherever tubers are exposed to exceptionally high temperature or given inadequate ventilation. Moist, dark-colored, depressed areas on the surface, or irregular, purplish to black portions in the interior.

Control: Keep in moderate to low temperature, not below 32° F., and provide ample aeration in storage and transit.

Common scab (Actinomyces scabies).—Prevalent everywhere, but greatly influenced by soil and temperature. Corky incrustations or rough, pitted spots, isolated or more or less covering the tuber surface. Sometimes slightly sunken, but usually protuberant. Causal fungus disseminated on the seed and persistent in the soil.

Control: Treat with formaldehyde or mercury bichloride, where seed is infected. Practice rotation, and plant humus-building crops. Use sulphur and acid-producing fertilizers to acidify the soil. Avoid lime, ashes, and fresh manure.

Curley dwarf (a virus disease).—Curling, spindlingness, uprightness, wrinkling, and slight ruffling of the foliage. Curly-dwarf plants produce small, spindle-shaped, gnarled, and frequently cracked tubers. A dwarf type of spindle tuber.

Control: Same as for mild mosaic.

Dry rot (Fusarium sp.).—Occurs chiefly as a storage rot, but occasionally present on newly dug potatoes. Dry decay originating on the surface in an injury or at the stem end, and often spreading into the center of the tuber.

Control: Fusarium wilt is controlled in the field. Give as careful handling to stock as possible in digging and storage operations to avoid bruising. Provide low temperature and free circulation of air in storage place.

Early blight (Alternaria solani).—Occurs throughout the United States. Round to irregular spots with target-board markings on leaves. Shallow, circular or irregular, dry decayed areas on tubers. Usually present to some extent every year, especially in short potato rotations.

Control: Spray as for control of late blight. In severe cases destruction by burning of affected foliage and longer rotation of potatoes may be necessary.

Eelworm galls (Heterodera radicicola).—Southern in its range. Pimplelike to knotlike swellings distributed over the tuber surface; watery within, and containing white glistening spots—female nematodes.

Control: Rotation of crops, and avoidance of infected tubers for seed.

Frost injury.—Soft and dark areas at surface of tuber to diffuse brownish or purple spots and strands of flesh.

Control: Avoid exposing potatoes at any time to a temperature below 32° F.

Hopper burn and tipburn.—Widespread. Withering of leaves at tips and along margins, particularly of the younger foliage. In part caused by intense loss of water from the leaves in bright, warm days after wet weather, but mostly by sucking insects, such as leaf hoppers and aphids.

Control: Spray with Bordeaux at regular intervals as for control of late blight, even when no blight is present. Add nicotine to the spray when aphids are present.

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Internal brown spot.—Cause undetermined. Dry, brown spots or blotches scattered through the flesh of the tuber.

Control: Use good cultural conditions to provide proper soil drainage and aeration.

Late blight of foliage (*Phytophthora infestans*).—Occurs mostly in the northern potato States, and on the early crop in Florida. Becomes epidemic in July and August in years of moist, cool weather. Causes irregular, water-soaked areas on leaves and stems, killing entire plant in a few days under favorable conditions. "White mildew" covers these areas during rainy periods, or early in the morning.

Control: Spray with Bordeaux (4–4–50 or 5–5–50), using as high pressure as possible. Begin when plants are 10 to 12 inches high, and repeat at least once in 10 to 14 days, and oftener in wet weather.

Late-blight rot of tubers (*Phytophthora infestans*).—May be present wherever late blight of the foliage occurs. In the field rusty, brown areas appear on tubers and spread rapidly. In storage, a diffuse, dark-brown, dry rot starts at the surface. May spread through the tuber if temperature is above 40° F. and humidity is high.

Control: Do not store tubers showing field rot with sound stock. Reduce field infection by avoiding digging in wet weather, or by waiting for a light frost to kill the vines of blighted fields. Keep storage temperatures below 40° F., and provide free air circulation by storing in crates or on racks in a place that has an efficient ventilation system.

Leaf-rolling mosaic (*a virus disease*).—Differs from mild mosaic in rolling mainly of the upper leaves and in diffused mottling.

Control: Same as for mild mosaic.

Leaf roll (*a virus disease*).—Upward rolling, rigidity, leathery texture, dwarfing, and chlorosis; yellowish, reddish, or purplish discoloration of the leaves. Shortness of stolons. Reduction in the number and size of tubers. Seed piece usually intact throughout the season.

Control: Same as for mild mosaic.

Mild mosaic (*a virus disease*).—Occurs wherever diseased tubers of susceptible varieties are planted. Symptoms and importance vary with extent of infection, weather conditions, and varieties. Leaves mottled by light and dark green patches vaguely defined. Leaves also slightly dwarfed, wrinkled, and ruffled.

Control: Plant disease-free seed potatoes in areas isolated from diseased plants. Careful inspection and elimination of all diseased plants from seed-potato fields or tuber-unit plots. Grow seed potatoes in localities known to be favorable for production of mosaic-free stock.

Powdery scab (*Spongospora subterranea*).—Occurs principally in northern potato sections. Only slightly important. Circular pits beneath the skin of the tuber that contain a brown powder, or blisterlike formations that rupture the skin.

Control: Do not use affected tubers for seed in regions favorable to the disease.

Rhizoctonia, or black scurf (*Corticium vagum*).—Occurs wherever potatoes are grown, but is favored by low temperature and moist soils. Attacks sprouts and growing plants below the soil line, causing misses, stem-rot, girdling, aerial tubers, and sometimes "big top" and "little potato." Causes black scurf, russet scab, and often cracks and rough pits on the tubers.

Control: Rotation, good drainage, and clean cultivation. Seed treatment, when black scurf is present, with formaldehyde or mercuric chloride.

Rugose mosaic (a virus disease).—Occurs wherever diseased tubers of susceptible varieties are planted. Cause is undetermined. Symptoms and importance vary with weather conditions, extent of infection, and varieties. Rugose type of wrinkling, diffused mottling, light-green areas generally along veins, a tendency to show brittleness, spotting, streaking, and leaf dropping, and distinct dwarfing.

Control: Same as for mild mosaic.

Silver scurf (Spondylocladium atrovirens).—Widely distributed and prevalent, but does not cause severe damage. Superficial layers of skin killed, so that the skin shrivels and takes on a silvery appearance in storage.

Control: Do not use severely affected tubers for seed.

Sunburn, sunscald, and heat necrosis.—Greenish or brown watery patches on the surface. Discolorations of the vascular ring near the stem and ranging to diffuse browning in the flesh outside this ring.

Control: Avoid exposing tubers to sunlight while they are growing or after digging them. Dig as soon as the vines are dead, especially if the soil is light and the temperature high.

Spindle tuber (a virus disease).—Occurs in important potato sections throughout the United States. Cause undetermined. Spindle-shaped, more or less cylindrical tubers, with more conspicuous eyes than in normal tubers. More or less spindling and upright stalks having slightly darker-green leaves than in healthy plants.

Control: Same as for mild mosaic.

Streak.—Occurs in northern United States from coast to coast. Cause undetermined. Streaking, spotting, burning, dropping, and premature death and brittleness of the leaves and stalks. Plants of second generation of certain varieties are severely dwarfed, curled, and streaked, and may die before tuber formation.

Control: Same as for mild mosaic.

Wart (Synchytrium endobioticum).—Occurs only locally in Pennsylvania, Maryland, and West Virginia. Spongy, cauliflowerlike growth at crown of plant, or from the tuber eyes, or the tuber entirely replaced by overgrowths.

Control: Plant immune varieties, such as Green Mountain, Irish Cobbler, Spaulding Rose, Burbank, and McCormick.

Wet rots.—Complete collapse of tuber in a slimy or jellylike, white or dark, usually foul-smelling rot. Caused by bacteria which follow late blight, tuber rot, and freezing injury, or by species of Fusarium and other fungi under certain conditions.

Control: Avoid storing tubers that have late-blight rot with sound ones. Keep storage temperature below 40° and above 32° F. Avoid storing potatoes in sacks or piled deep in bins.

Wilt.—Caused by the fungi Verticillium in the North, Fusarium in the Central and Western States, and by a bacterial parasite in the South. Sources of the disease and the means of spread differ for these different parasites, but either the seed or soil may serve to perpetuate the disease. Plants turn yellow, and mature or dry up slowly in moist weather, but wilt suddenly in hot, dry weather. Growth of plants stopped and yield of tubers reduced.

Control: Avoid use of seed potatoes showing rot or marked discolorations at stem end, or discoloration of vascular ring extending into the center of the tuber. A long rotation helps to reduce the disease, but in the South, where bacterial wilt is prevalent, the planting of potatoes on new land should be avoided. Do not use

seed at all from fields where much wilt was present. Avoid soil badly infested with wilt.

Sweet Potato (53)—*Black rot* (*Ceratostomella fimbriata*).—Occurs widely. Characterized by roundish, black, sunken spots on the potatoes. Diseased slips in the hotbed show black spots on the stem below the soil line, or the slips may rot off and die soon after being set in the field.

Control: Seed selection and treatment as for stem rot. Preparation of clean hotbed each year from noninfected soil. Crop rotation.

Foot rot (*Plenodomus destruens*).—Limited to comparatively few sections. Occurs especially in Virginia, Ohio, and Iowa. Appears about midsummer on the stem near the soil line. Decay extends about 5 inches above soil and downward to the roots. Pycnidia are abundantly formed in the decayed area.

Control: Plant only healthy slips. Disease comes largely from the use of infected potatoes. Follow directions for selection and treatment given under black rot and stem rot.

Leaf blight (*Phyllosticta batatas*).—Widespread in South and East. Roundish or angular spots, one-eighth to one-half inch in diameter, on upper side of leaf. Within this area are found a number of black, slightly raised bodies about the size of a pin point and just visible to the naked eye.

Control: No control measures necessary.

Leaf spot (*Septoria bataticola*).—Widespread in South and East. White spots one-eighth inch or less in diameter on the leaf. Within the white area one to four black specks may be found, just visible to the naked eye.

Control: No control measures necessary.

Scurf (*Monilochœtes infuscans*).—Common disease. Irregularly shaped, brownish, discolored spots of various sizes on the surface of the underground parts. Fungus does not break the skin of the potato and is so superficial as to be scraped off easily by the finger nail.

Control: Same as for black rot.

Soil rot (*Cystospora batata*).—Occurs in the East and South. Pits of various sizes and depths, with jagged edges, on the fleshy root. Small, black, decayed spots may be found anywhere on the small rootlets.

Control: No effective control methods known. Acid fertilizers reduce the amount of infection. Some varieties are resistant to soil rot. Rotation of crops is of value.

Stem rot (*Fusarium batatatis, F. hyperoxysporum*).—Present in most sweet-potato sections. Plants become stunted and leaves turn yellow, particularly the apical leaves, after which the plants wilt and die. Stems black inside. Cut potatoes show a black ring.

Control: Select disease-free potatoes at digging time for seed. Disinfect seed in mercuric chloride (1 to 1,000) for eight minutes. Prepare new hotbed each year.

Texas root rot (*Ozonium omnivorum*).—Occurs in Texas, Arizona, and New Mexico. Infection takes place on underground parts of the plant. Disease spreads in both directions, attacking the vine and the roots. Firm dry rot of the potato is produced. Vine may be invaded for several inches.

Control: Plant potatoes on light, sandy soils. Rotate with cereals. Practice deep plowing and clean cultivation.

White rust (*Albugo ipomœæ-panduranæ*).—Widespread in South and East. Slimy, white, fungous growth on under side of leaves in irregularly shaped spots. Loss of green color in the spots. Occurs also on tender vines. Causes malformation of all attacked parts.

Control: No remedial measures required.

Bulb Crops

Onion (54)—*Black mold* (*Aspergillus niger*).—General. Sometimes especially destructive to the California and Texas crops. Superficial, black powder on bulbs, often extending between scales.

Control: Cure promptly and keep as dry as possible.

Fusarium bulb rot (*Fusarium sp.*).—Occurs in most northern sections of United States and on the Pacific coast. Semiwatery decay starting at the base of bulbs a little before harvest.

Control: Change to new land. Sort out incipient decay at harvest.

Downy mildew (*Peronospora schleideni*).—Occurs in humid eastern and Gulf coast sections, and on the Pacific coast. Pinkish-gray, fuzzy growth on leaves during moist weather, causing the collapse of attached parts.

Control: Rotate crops. Provide air and soil drainage. Spray with Bordeaux, if a start can be made early enough to ward off disease.

Neckrot (*Botrytis sp.*).—Generally distributed. Semiwatery decay starting at neck and progressing downward.

Control: Cure onion sets artificially. Otherwise same as for smudge.

Smudge (*Colletotrichum circinans*).—Occurs in eastern United States. Black, peppery spots on outer scales of white bulbs.

Control: Cure the crop as promptly as possible. Avoid exposure to rain after harvest.

Smut (*Urocystis cepulæ*).—Occurs principally in older regions north of Virginia, Kentucky, and the Missouri River. Has recently proved troublesome in certain onion-growing localities of Oregon. Opaque swellings in leaves, which eventually rift open, exposing smut spores.

Control: Use formaldehyde drip control. (See Seed Treatment.)

Soft rot (*Bacillus carotovorus*).—Generally distributed. Watery rot, with repulsive odor, often affecting one or more inner scales, starting at neck.

Control: Cure promptly. Sort out decay at harvest.

Greens and Salad Crops

Celery (55)—*Bacterial leaf spot* (*Bacterium apii*).—Found in New York, Michigan, and Minnesota. May also occur in other States. Small water-soaked spots on leaves.

Control: Spray with Bordeaux mixture shortly after plants have been transplanted.

Black heart.—Occurs chiefly in Florida and California commercial districts. Nonparasitic disease. Yellow appearance at tip of older leaves, premature death at heart that appears brownish black, first dry rot and later secondary soft rot.

Control: Use resistant varieties. Irrigate properly. Cut celery when mature.

Brown stems.—Nonparasitic disease. Widely distributed. Brown lesions extending several inches up and down stems.

Control: Irrigate properly. Cut celery before it passes stage of maturity.

Cracked stems.—Caused by the cracking of vascular ribs of the stems.

Control: No definite measures known. Avoid excessive use of acid phosphate and lime, and irrigate properly.

Damping off (*Pythium de Baryanum, Sclerotinia sclerotiorum, Fusarium, sp., Rhizoctonia sp.*).—May occur anywhere celery is grown. Damping off or decay of young plants near the surface of the ground.

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Control: Sterilize seed beds. Cultivate thoroughly, and avoid excessive moisture.

Early blight (*Cercospora apii*).—Generally distributed with crop. Irregular or circular spots on leaves with ashen gray centers and yellow margins, resulting in premature death of leaves.

Control: Spray with Bordeaux mixture (5–5–50), in both seed bed and field every 10 days to two weeks.

Heart rot or slimy soft rot (*Bacillus carotovorus*).—Widely distributed in United States. Slimy decay of plant and heart near the crown.

Control: Sterilize seed beds with steam or formaldehyde. Rotate crops.

Hollow stem and pithiness.—Nonparasitic disease; generally distributed with the crop. Causes pithy stems of plants.

Control: Plant resistant varieties according to seasonal appearances. Avoid excessive use of acid phosphate.

Late blight (*Septoria petroselini*).—Generally distributed. Most troublesome in New England, Middle Atlantic, and Lake States. Occurs on leaves and stems. Small brownish-black spots with small specks in center, surrounded by brownish-yellow margin.

Control: Use seed that is 3 years old. Spray plants with Bordeaux mixture in seed bed and field.

Mosaic (*a virus disease*).—Found in Massachusetts, New York, New Jersey, Indiana, California, and probably other States. Yellow and mottled appearance of leaf. Cause undetermined.

Control: No control, but spread may be checked by control of aphids.

Phoma root rot (*Phoma apiicola*).—Dark discoloration of stems just above the ground, and dying of few outer leaves. Black, scurfy appearance on crown and roots of plants.

Control: No definite control measures, but advisable to use only healthy plants from seed bed, to rotate crops, and to remove all diseased plants.

Pink limb rot and foot rot (*Sclerotinia sclerotiorum*).—Found in most celery sections. Watery, soft, pink decayed spots with white margins, later with hard black bodies over surface.

Control: Rotate crops. Remove diseased plants from field and burn. Spray with Bordeaux mixture, applying it to the stems. Do not follow lettuce with celery.

Red root.—Cause undetermined. Roots redden and turn brown and become apparently lifeless.

Control: No definite control, but avoid highly acid soils.

Root rot and stem browning (*Rhizoctonia sp.*).—Decayed roots and brown stems near surface of ground.

Control: Sterilize seed beds.

Root knot (*Heterodera radicicola*).—Found on sandy soils of the Southern States. Enlarged roots; plants yellow and stunted.

Control: Sterilize seed beds with steam. Rotate with resistant crops. When feasible, flood the field during summer.

Stunting.—Description: Plants in the fields become stunted in growth and dwarfed in appearance.

Control: Set plants properly. Avoid soil that is infested with root knot.

Yellows (*Fusarium sp.*).—Known in New York, Ohio, Michigan, Indiana, Minnesota, and Colorado. Disease increasing in commercial districts. Stunted plants with yellow color.

Control: Sterilize seed beds. Grow resistant strains.

Lettuce—*Bottom rot* (*Rhizoctonia*).—Generally distributed. Rot of bottom leaves that rest on ground, but never of the main stem.

Control: Keep surface of soil as dry as possible with drainage and cultivation. Sterilize soil in greenhouse.

Bacterial leaf spot (*Bacterium marginale*).—Small irregular spots on leaves. Water-soaked appearance.

Control: No definite measures to follow.

Brown blight.—Brown, dead streaks, blotches, or areas on leaves.

Control: Rotate crops. Use resistant strains.

Damping off (*Pythium de Baryanum*).—May occur anywhere. Sudden death and damping off of plants in seed bed.

Control: Keep surface of soil dry by thorough cultivation. Sterilize seed beds with steam.

Downy mildew (*Bremia lactucæ*).—Occurs in humid eastern sections and on the Pacific coast. Large, light-colored spots on lower leaves, and white-gray, downy growth on lower side of leaf.

Control: No definite measures known.

Drop (*Sclerotinia sclerotiorum, S. minor*).—Occurs throughout the United States on both field and greenhouse crops. Plants decay suddenly near surface of ground and wilt entirely; later completely decay.

Control: In greenhouse, sterilize the soil, cultivate, and keep surface dry. In the field, remove all affected plants and rotate crops.

Gray mold or botrytis rot (*Botrytis cinerea type*).—Occurs commonly under humid conditions in field and under glass. Dirty gray, fuzzy mold on lower leaves.

Control: Grow strong plants, since they are more resistant.

Mosaic (*a virus disease*).—Scattered in six or more Eastern States. Cause is not determined, but the disease is increasing in importance. Yellow and mottled appearance of leaf, and stunted plants.

Control: No definite measures to follow. Keep all weeds cut near the seed beds. Sow ground tobacco stems over bed to check aphis which spreads disease from one plant to another.

Root knot (*Heterodera radicicola*).—Found in the sandy soils of the Southern States. Sometimes troublesome in northern greenhouses. Enlarged roots.

Control: Rotate crops. Sterilize seed beds with steam.

Tipburn.—Nonparasitic disease. May occur anywhere lettuce is grown. Edges of leaves turn brown and die. Decay often sets in later.

Control: No control under field conditions. In greenhouse, avoid excessive moisture and high temperature.

Cabbage Crops

Cabbage (57)—*Blackleg* (*Phoma lingam*).—Occurs chiefly east of Rocky Mountains. Gray, peppery spots with purple margins, on leaves, stems, and seed plants. Lesions at base of main stem girdle plant, causing wilting. Root system is largely decayed.

Control: Rotate seed bed. Disinfect seed with hot water. **(56).**

Black rot (*Bacterium campestre*).—Generally distributed with crop. Yellow blotches start at margins of leaves and blacken all veins encountered; seen when held to the light. Blackening of veins extends down to main stem, thence up to other leaves. One-sided development of plant is common.

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Control: Rotate seed bed. Disinfect seed. Avoid plants from diseased beds. (56).

Clubroot (*Plasmodiophora brassicæ*).—Occurs throughout the North and on the Pacific coast. Plants stunted, do not head, and often wilt; large malformations develop on roots.

Control: Rotate crops. Apply lime to soil to correct acidity. Drain wet spots. Avoid diseased plants.

Soft rot (*Bacillus carotovorus, B. oleraceæ*).—Occurs wherever cabbage is grown. Usually follows black rot, injuries, bruises, and freezing. Soft, watery rot that may run up the core.

Control: Do not store stock from fields infected with black rot. Have stock as dry as possible before storing. Keep temperature of warehouse at 30° to 32° F., and ventilate well.

Yellows (*Fusarium conglutinans*).—Most destructive in central regions east of the Rocky Mountains. Not yet reported from New England. Less serious along northern limits of cabbage culture. Leaves turn yellow in warm weather, drop off gradually; veins turn dark brown; root system sound; one-sided development of plants common.

Control: Use resistant varieties.

Legumes

Bean—*Anthracnose* (*Glomerella lindemuthianum*).—Widespread and destructive. Somewhat round, sunken spots with reddish edges, on the young pods. Red spots or streaks on veins on under sides of leaves. Causes rusty-looking spots on the ripe seed.

Control: Use disease-free seed. Plant where disease has not occurred the previous year.

Bacterial blight (*Bacterium phaseoli*).—Found in all bean-growing centers of the United States. Large, irregular brown spots with a bright yellow border, often covering the greater part of the leaf. Infection first visible as tiny water-soaked spots on the underside of leaf. Pods show irregular water-soaked areas, becoming reddish and sunken. Yellow bacterial ooze. Stems show longitudinal reddish streaks.

Control: Select seed from blight-free plants. Use western-grown seed, if possible. Avoid cultivating when plants are wet. Do not use bean straw as fertilizer or feed. (51), (58).

Bacterial brown rot (*Bacterium solanacearum*).—Reported from Florida only. Plants stunted and wilted, with interior of roots and stem turning brown.

Control: Rotate crops, avoiding in the rotation tobacco, tomato, potato, eggplant, and peppers, which are also subject to brown rot.

Bacterial spot (*Bacterium viridifaciens*).—Reported from Wisconsin and New York, but this, or a very similar disease, severely attacked both string and Lima beans in Virginia and Maryland in 1924. Round or irregular, brown to purplish-red spots on leaves, becoming gray in center, with purplish red margins. Earliest signs on pods are small, brown spots with water-soaked halos. Veins of infected seed may be reddish. Reddish-brown streaks on veins and petioles of leaves, on stems, and along sutures of pods.

Control: No control measures known.

Bacterial wilt (*Bacterium flaccumfaciens*).—Found in Michigan, Montana, South Dakota, Virginia, and Maryland. Complete distribution unknown. Wilting and death of seedlings, wilting of whole or part of older plants, dwarfing, and reduction of yield. Diseased plants frequently break over. Yellowish-green, dull-green, or

olive-green discoloration of the suture, most noticeable in mature pods. Pods may bear no external sign of infection, and yet contain infected seed. Seed of white-seeded varieties are bright yellow because of thick bacterial-layer beneath the seed coat and showing through it. Seeds of colored-seeded varieties appear brownish.

Control: Use wilt-free seed, since the disease is disseminated through the seed. Do not plant seed from wilt-infested fields or use bean straw as fertilizer or feed.

Downy mildew (*Phytophthora phaseoli*).—Found from Vermont to Virginia and Ohio. Common on Lima beans. Disease appears as dense, woolly-white growth in patches. Occurs on young shoots, petioles, and leaves.

Control: Practice seed selection and crop rotation. Spray with Bordeaux mixture, making three or more applications.

Mosaic (*a virus disease*).—Widespread. Important on susceptible varieties. Cause undetermined.

Control: No definite remedy.

Pod blight (*Diaporthe phaseolorum*).—Found east of the Mississippi River, especially on the coast and in Louisiana. Large brown patches with pycnidia arranged in concentric circles are produced on Lima-bean pods. Spots smaller on leaves and more irregular in shape.

Control: Selection of clean seed and crop rotation.

Powdery mildew (*Erysiphe polygoni, Microsphæra diffusa*).—Widespread. White mealy patches on the leaves and stems. Foliage later turns yellow.

Control: Dust with flowers of sulphur or spray with potassium sulphide at the rate of 3 ounces in 10 gallons of water.

Root rot (*Fusarium martii var. phaseoli*).—Widely distributed. Destruction of skin of the underground parts of the plant. Where present, often general throughout the entire field.

Control: No remedial measures known.

Rust (*Uromyces appendiculatus*).—Common and often destructive. Occurs on all parts above ground, but most conspicuously on leaves. On foliage the rust appears as little brown pimples. Pimples later turn black.

Control: Grow resistant varieties.

Southern blight (*Sclerotium rolfsii*).—Occurs in South Carolina, Georgia, and the Gulf States. Yellowing and wilting of the leaves, which die and finally drop. Attacks the plant just below ground, invades the cambium layer, and destroys it.

Control: No remedy known.

Pea—*Bacterial blight* (*Bacterium pisi*).—Fairly widespread. Water-soaked, translucent spots on leaves, pods, and stems.

Control: No control known.

Blight or leaf and pod spot (*Ascochyta pisi* and *Mycosphaerella pinodes*).—Occurs widely. Brown spots on leaves and pods and blackened stem. Seeds become infected underneath pod spots.

Control: Use clean seed with a three to four year rotation.

Downy mildew (*Peronospora viciæ*).—Distribution scattered. Usually of importance. Yellowed leaves; gray or purplish mildew on undersurface; favored by wet weather.

Control: Rotate crops. Provide proper drainage.

Powdery mildew (*Erysiphe polygoni*).—Widespread. Gray mildew on both surfaces of leaves, also on pods and stems. Black spore cases appear in midst of gray mildew toward end of season.

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Control: Early planting, proper drainage.

Root rots (*Aphanomyces euteiches, Pythium sp., Fusarium martii pisi*).—Prevalent and especially important in the older commercial pea-growing sections. Plants yellow or unthrifty at blossoming period and stem and root decayed. Disease may start when plants are 6 to 8 inches high.

Control: Rotate crops. Avoid infested land for seven or eight years. Use resistant varieties. Not known to be seed borne.

Vine Crops

Cucumber (51)—*Anthracnose* (*Colletotrichum lagenarium*).—Widespread. Light-brown, circular spots one-fourth to one-half inch in diameter appear on the leaves, and dry, elongated, chalky, sunken areas on stems. On nearly ripe fruits, roundish sunken spots occur, at first pinkish and later becoming dark.

Control: Disinfect seed as for angular leaf spot. Rotate crops and plant on land that has not been in vine crops for several years. Spraying with Bordeaux mixture (4–4–50) will delay the progress of the disease.

Angular leaf spot (*Bacterium lachrymans*).—Widespread. Small, angular spots one-eighth inch in diameter appear on leaves; at first water-soaked, later turning light brown to almost white. On the fruits small whitish spots are produced.

Control: Soak seed for five minutes in mercuric chloride (1 to 1,000) solution, then wash thoroughly. Rotate crops. If disease appears, spray as for downy mildew.

Bacterial wilt (*Bacillus tracheiphilus*).—Widespread. Affected plants wilt and die very quickly because of bacteria plugging the water vessels. Disease carried over winter and disseminated by striped beetles. Generally most severe in early part of season, when beetles are most abundant.

Control: Pull and bury or burn wilted plants early in season. Control striped beetles in the garden by inclosing plants with insect-proof cages or in the field by spraying with Bordeaux (4–4–50) with lead arsenate.

Downy mildew (*Pseudoperonospora cubensis*).—Common in Eastern, Southern, and Central States in favorable years. Yellowish, faintly angular spots apparent on older leaves, which soon curl, dry up, and die.

Control: Spray with Bordeaux mixture (4–4–50) just before disease usually appears, in the South, when first fruit sets, and repeat at 7 to 10 day intervals.

Mosaic (*a virus disease*).—Fairly common in most sections. Cause undetermined. Plants are stunted and have wrinkled, mottled, and yellowish leaves and misshapen fruits with conspicuous green warts.

Control: Pull all host plants of mosaic in and near cucumber fields, including wild cucumber, milkweed, pokeweed, and ground cherry. Mosaic overwinters in their seed or roots. Control insects to prevent spread.

Scab (*Cladosporium cucumerinum*).—Common and often severe in the more northern pickle-growing section in cool, moist seasons. Characterized by sunken spots on the fruits, especially the younger ones, also on stems and leaves. At first the spots are water-soaked and at night are covered with a copious gummy exudate. During the day this dries and the spots become shrunken and grayish-green in color and covered with spores.

Control: Rotate crops, as the disease lives over winter in the soil. Avoid too thick planting, or thin the plants to give plenty of air.

Muskmelon (Cantaloupe)—*Anthracnose*.—(See Cucumber.)

Bacterial wilt.—(See Cucumber.)

Downy mildew.—(See Cucumber.)

Macrosporium blight (*Macrosporium cucumerinum*).—Quite common and often severe in many sections of the country in moist seasons. Fungus causes small, brownish-red target-board spots on older leaves, which soon curl, dry up, and die. Fruit on such vines fails to mature or ripens prematurely and is lacking in quality.

Control: Rotate crops; use resistant varieties. Spray thoroughly with Bordeaux mixture (5–5–50) to hold disease in check.

Mosaic.—(See Cucumber.)

Powdery mildew (*Erysiphe cichoracearum*).—Especially severe on muskmelons in the Imperial Valley, Calif., during recent years. Not generally troublesome elsewhere except in greenhouses. Fungus produces rounded, whitish to tawny spots half an inch in diameter on leaves, causing them to curl, dry up, and die. Fruit on badly affected vines fails to mature properly and is of poor quality.

Control: Spraying or dusting wih Bordeaux preparations generally ineffective. In the greenhouse mildew is controlled by the application of sulphur to the steam pipes. In the field no entirely satisfactory control is yet available. Most sulphur compounds applied to the plant have caused serious burning of the foliage.

Watermelon—*Anthracnose* (*Colletotrichum lagenarium*).—Generally distributed. Numerous irregular black spots appear on leaves which, after a few days, tend to shrivel and curl. Fruits on affected vines show irregular, black sunken spots, or more often spots like green pimples with a yellow cast in the center. Large, flattened elevations sometimes appear on the rind. When conditions are very moist, pimples or "nailhead spots" become sunken, enlarged, and covered with masses of pink spores.

Control: Treat seed with mercuric chloride (1 to 1,000) for five minutes, and wash in running water before planting. Protect vines by spraying with Bordeaux (4–4–50).

Gummy stem blights (*Mycosphœrella citrullina*).—Generally distributed. Plants die from centers outward. Root just below the ground and branches leading up are partly killed, and may show presence of irregular ash-gray cankers on which fruiting bodies of the fungus may be seen as minute black spots. Browning and dying of tissues is accompanied by profuse exudation of red gum. Disease may or may not kill the plant completely. Poorly developed fruits, which may rot at the blossom end, sometimes form on diseased plants.

Control: Not well worked out. Seed treatment and spraying with Bordeaux (4–4–50) are helpful.

Root knot (*Heterodera radicicola*).—Occurs in Southern States. Vines become stunted and yellowed, roots generally swollen, distorted, and knotted.

Control: Rotate crops, using nonsusceptible crops, such as winter grains, corn, velvet beans, and resistant cowpeas.

Wilt (*Fusarium niveum*).—Generally distributed. Affected plants wilt suddenly and do not recover. Usually one branch after another wilts, beginning at the tip, and dries up until the entire vine is dead. If the stem is cut across near the root, the woody portion will be found to be discolored.

Control: Do not plant twice in the same place, if wilt is present. Use a rotation of 10 years or longer if practicable. Avoid drainage water from diseased fields. Do not use infested stable manure or compost.

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Stem-end rot (*Diplodia sp.*).—Rapid decay, beginning at the stem end, which develops during transit to market.

Control: Instruct laborers in the field at harvest time not to handle melons found decaying at the blossom end. Avoid knife cuts and other injuries to the rind. Handle carefully to avoid bruising or cutting the rind and cracking or splitting the stem. Harvest only melons with firm, green stems, and load on dry bedding. Finally at the car reclip the stems and apply a 6 per cent copper-sulphate disinfectant paste.

Other Annual Crops

Eggplant—*Brown rot* (*Bacterium solanacearum*).—Generally distributed through the Southern States.

Control: See Granville wilt of tobacco.

Leaf and fruit spot (*Phomopsis vexans*).—General. Damping off of seedlings. On older plants, disease is characterized by stem cankers, a leaf spot, and later a fruit rot. Leaf spots are circular gray to brown areas, with the center lighter than the marginal zone. Numerous small black fruiting bodies are visible on older leaf spots. On the fruit pale sunken areas appear, and on these fruiting bodies will be found.

Control: Rotate crops. Destroy diseased plants. Use disease-free seed. Spraying with Bordeaux mixture (4–6–50) will help.

Root knot (*Heterodera radicicola*).—Found in Southern States. Plants become dwarfed and sometimes die. On examination roots will be found to be swollen and knotted, showing presence of galls.

Control: Rotate crops, and if practicable sterilize soil before planting.

Southern blight (*Sclerotium rolfsii*).—Occurs in Southern States. Plants wilt and sometimes die, a dense, white fungous mat occurring at base of stem or on roots.

Control: Same as for stem rot.

Stem rot (*Corticium vagum, Rhizoctonia*).—General. Cankers appear at soil line or on roots and are accompanied by a growth of fine, pale or dark fungous threads, which may sometimes be seen with the naked eye when affected plants are pulled from the ground. Small, black irregular bodies (sclerotia) often appear.

Control: Destroy refuse. Disinfect soil, when practicable.

Wilt (*Verticillium alboatrum*).—Occurs in Northern States. Plants become stunted and assume a yellow cast, and the lower leaves wilt and drop off. A cross section of stem will show dark-brown discoloration of woody tissues.

Control: Not well worked out. Rotate crops and avoid use of manure which contains vegetable refuse.

Pepper—*Anthracnose* (*Colletotrichum nigrum*).—General. On fruit, disease first appears as small water-soaked spots or darkened, soft depressed areas, which increase rapidly in size and change to lighter color with age. Fruiting bodies form over the diseased spots, often followed by soft-rot organisms.

Control: Rotate, disinfect seed, destroy diseased fruits, and spray with Bordeaux mixture (3–6–50).

Brown rot (*Bacterium solanacearum*).—See Southern Wilt of potato.

Leaf spot (*Cercospora capsici*).—General. Characterized by water-soaked spots which, as they become dry, turn white and have a dark-brown margin. Sometimes causes stem-end decays of fruits.

Control: Same as for anthracnose.

Tomato—*Bacterial wilt* (*Bacterium solanacearum*).—Widely distributed, but most common in the warmer regions of the United States. Plants wilt and show many signs of the symptoms occurring in Fusarium wilt, including the discoloration of tissues between bark and pith, but discoloration is usually light yellow to brown instead of dark brown, and not infrequently extends into pith. Infected tissues contain a dirty liquid, which may be squeezed out of cut stems by the fingers. Disease usually starts in roots and spreads upward, but not infrequently starts near tip of branches and spreads downward. Infected plants die rapidly.

Control: Rotate with resistant crops, such as corn, wheat, rye, cotton, grasses, sweet potatoes, red clover, and crimson clover. Do not use tobacco, potatoes, or peanuts in rotation. Keep weeds out of field, since many are affected by this disease.

Blossom drop.—Common in Southwest. Appears sporadically in most other parts of the country. Blossoms form freely, but little or no fruit sets, especially in the lower clusters. Often caused by unbalanced soil condition, such as excess or deficiency of nitrogen, or an overabundance of water. It is also induced by sudden cold periods and by dry, hot winds.

Control: Determine and overcome local cause. Excess of fertilizer or water overstimulates growth and causes hindrance to pollen development. Blossoms will shed because they are not pollenized. Hand pollination of the first clusters is sometimes helpful. If hot, dry winds are the cause, use earlier or later varieties or try a different time of planting.

Blossom-end rot.—Distribution general. Disease probably nonparasitic. Black, leathery spot at blossom end of fruit. Most common during droughts after periods of very rapid growth, but sometimes more or less abundant in very wet weather.

Control: May be prevented by timely plowing, frequent shallow cultivation, and other field practices that tend to keep the soil moderately moist.

Buckeye rot (*Phytophthora terrestria*).—Found chiefly in Southern States. Grayish-brown to chocolate-colored fruit rot, accompanied by more or less mottling and wide concentric markings. Common only on wet soil.

Control: Stake the plants to keep fruit off the ground.

Collar rot.—Common in seed beds in tomato-canning regions in Middle Atlantic States. Characterized by a brown rot at base of stem. Plants seldom infected in field.

Control: Disinfect seed before sowing. Use soil free from disease for seed beds. If necessary sterilize soil with steam, formaldehyde, or some of the organic mercury compounds now on the market. Do not use infected plants.

Early blight (*Macrosporium solani*).—Widely distributed, but most common in the East and in California. Characterized by irregular brown spots with target-board markings on stems and leaves, and by a black spreading rot on fruit.

Control: Plow under the old tomato vines and other crop refuse at end of picking season. Use thoroughly fall-plowed land for tomato crop. If heavy washing from rains makes fall plowing impracticable, plow deeply in the spring and cultivate shallow so as not to bring the buried material to the surface. Spray plants with Bordeaux mixture every week or 10 days.

Fusarium wilt (*Fusarium lycopersici*).—Common in South, Middle East, Middle West, Colorado, Utah, and coastal region of California. Marked wilting of plants

and upward rolling of leaves occur about the time the first fruits begin to ripen, followed by a yellow discoloration and drooping of leaves which begin at base of stems and progress slowly toward tips of branches. Infected branches finally die and shrivel at tips. Dark-brown discoloration develops in the woody area between bark and pith. Infection may be traced through roots, stems, and branches into the fruits and seeds by means of this discoloration.

Control: Rotate crops and use wilt-resistant varieties.

Late blight (*Phytophthora infestans*).—Most common in the North and in mountainous regions of the South. Thrives best under cool, moist conditions. Black areas appear on stems and leaves. In severe cases plants die suddenly as if killed by frost. Brown rot develops in the fruit, usually at the stem end.

Control: Spray thoroughly with Bordeaux mixture every week or 10 days.

Leaf spot (*Septoria lycopersici*).—Widely distributed east of Rocky Mountains. Causes heavy losses in Middle Western and Middle Atlantic States. Occurs only on stems and leaves as small circular spots with gray centers and brown margins, usually bearing scattered minute black bodies about the size of flyspecks. Heavily infected branches become defoliated, but continue to produce a few green leaves at the tips.

Control: Plow under all the old vines, dead weeds, and other crop débris at end of picking season. Plant the crop on fall-plowed land in which all crop remains and other dead materials have been thoroughly buried by the use of a weedhook or jointer.

Nailhead rust (*Macrosporium tomato*).—Occurs chiefly in Gulf States, but occasionally found as far north as New Jersey. Characterized by small irregular to circular brown spots on the foliage and by reddish-brown to olive-gray circular spots on the fruits.

Control: Use resistant varieties. Spray every week or 10 days with Bordeaux mixture. The second early trucking varieties, Marvelosa and Marglobe, and the late shipping and canning varieties, Norton and Norduke, are practically free from nailhead infections on the fruits.

Root knot (*Heterodera radicicola*).—Common in greenhouses and in the Southern States. Characterized by knots or galls on the roots and by gradual death of the plants.

Control: Grow resistant crops for two or three years, such as Iron, Brabham, Victor, or Monetta cowpeas, corn, barley, beggarweed, rye, redtop, sorghum, the Laredo soy bean, timothy, velvet beans, wheat, and winter oats.

Sclerotial blight (*Sclerotium rolfsii*).—Common in Southern States. Stems rot at surface of ground. Plants wilt from top downward. Small, yellow to reddish-brown sclerotia resembling mustard seed often present.

Control: Spray the soil around the stems with a solution of ammoniacal copper carbonate. Thoroughly cover the old vines, dead weeds, and crop refuse with soil when plowing.

Soil rot (*Rhizoctonia solani*).—Widely distributed. Causes brown cankers on the stems near the surface of the ground and a brown rot with narrow concentric markings on the fruit.

Control: Stake the plants to keep the fruits off the ground.

Sweet Corn—*Bacterial wilt* (*Aplanobacter stewarti*).—Important chiefly in the Corn Belt and eastward. Young infected plants may wilt and die or show almost white stripes in leaves. Plants may become greatly dwarfed and show sticky, yellow exudate from ends of water-conducting bundles when stalks are cut. Old infected plants usually show early maturity of tassels and premature dying of leaves. The ears may be absent, greatly reduced in size or light and chaffy, and the thin inner husks may show abundant yellow exudate. Early maturing varieties are most susceptible.

Control: Use disease-free seed and resistant varieties.

Black bundle.—(See .212.)

Root, stalk, and ear rots.—(See .212.)

Rust.—(See .212.)

Smut.—(See .212.)

Perennial Crops

Asparagus (59)—*Rust* (*Puccinia asparagi*).—Occurs in sections where susceptible varieties are grown. Tops yellow and die early. Foliage shows numerous elongated, orange or black raised spots.

Control: Plant rust-resistant varieties, such as Mary Washington or Martha Washington.

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CONTROL MEASURES

Methods

Quarantine.—The Federal plant quarantine act of August 20, 1912, empowers the Secretary of Agriculture to prohibit or to regulate the entry of foreign plants and plant products to prevent the entry into this country with such plants and plant products of new and dangerous plant pests, either insect enemies or plant diseases. It also empowers the Secretary to establish and to maintain quarantined districts within the United States for the purpose of preventing the spread of plant enemies or diseases which may have gained local foothold, and to cooperate with the States in measures looking to the extermination of such pests. Some 25 quarantines and restrictive orders, prohibiting or regulating the entry of foreign plants and plant products, are now being enforced for the purpose of excluding such pests as the Mediterranean and other fruit flies, the pink bollworm and other cotton pests, serious diseases of potatoes, cereals, and other important crops. Some 18 domestic quarantines are now being enforced to control the interstate movement of plants and plant products, having for their object the prevention of spread within the United States of such plant and forest enemies as the gypsy moth and the brown-tailed moth, the pink bollworm of cotton, the date-palm scale insects, the Japanese beetle, the European corn borer, and the white-pine blister rust. Some 200 State officials are now connected with the work of the board as collaborators and assist very materially in the enforcement of the Federal quarantine and regulatory orders.

Culture and Handling.—General health of the plant is a factor in determining its resistance to attack by disease-producing organisms. Plant and carry out culture so as to provide for suitable location and care of the crop in order to avoid subjecting it to unfavorable chemical and physical conditions of soil, temperature, and water. Such conditions not only are capable of producing disease independently, but also often affect the severity of attack of parasites. Use methods of handling the crop and of cultivating, pruning, spraying, or harvesting that will give no unnecessary aid to the spread of disease. Avoid wounding the trees, and when necessary to do so treat with a disinfectant and then waterproof. Unless working is unavoidable, bean fields affected with anthracnose should not be cultivated when the plants are wet. The same is true of cucumber plantings where angular leaf spot has started. Handle fruits and vegetables carefully during the period of harvest and preparation for shipment. When storing products, give attention to proper temperature and ventilation.

Eradication—*Diseased plants.*—Remove entire diseased plants which may serve as sources of infection to the main part of the crop, particularly those attacked by diseases that are readily transmissible from plant to plant. For example, rogue out cucumber plants affected with bacterial wilt, and uproot peach trees affected with yellows. This protects the other trees and plants in the community.

Plant parts.—Chance for spread of certain diseases can be reduced by cutting out or removing affected parts. For example, treatment of pear blight.

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Alternate hosts.—The causal organism of some diseases passes through two or more stages in its life history, the different stages being confined to specific plants. For example the fungus which causes cedar rust of apple must spend a period of its life history on the red cedar. The spores formed on apple can not reproduce the disease on apple, likewise the spores formed on red cedar can not reproduce on red cedar. Consequently the eradication of red cedar, which in this instance is the alternate host, removes the danger from this disease. Likewise, eradication of the common barberry, an alternate host to the fungus which causes stem rust of wheat, checks the danger in near-by wheat fields from this disease. Elimination of currant and gooseberry bushes protects healthy white pines in the vicinity from the white-pine blister rust.

Wild hosts.—Eradication of milkweed, wild cucumber, two species of ground cherries, and pokeweed, all of which are overwintering hosts for cucumber mosaic virus, is effective in greatly reducing danger resulting from the mosaic disease. This eradication should apply to all wild hosts in the cucumber field and within a circumference of 50 to 75 yards.

Use of Disease-Resistant Sorts.—Use of disease-resistant varieties that are available and suitable to the region is the most practical means of avoiding disease losses. Strains of asparagus and beans resistant to rust; yellows-resistant strains of several cabbage varieties; tomatoes, cotton, and cowpeas that resist the wilt diseases; spinach and varieties of sugar cane that can be grown without heavy losses from mosaic; and varieties of cereals resistant to rust diseases are included in the list of disease-resistant sorts now available for use.

Disease-Free Seed.—In some cases where disease-resistant varieties are not yet available, it is possible and best to procure disease-free seed or plants. Purchase seed grown in sections where certain diseases do not occur, or buy for planting purposes seed which has been grown with special care to prevent the occurrence or development of diseases, such as certified potatoes grown for seed purposes, which must meet certain requirements as to varietal purity and freedom from disease to pass the State inspection. Sweet potato, cabbage, and tomato plants, which have been certified by a State agency as to freedom from disease, are now available in some States and help to protect purchasers from diseased stock.

Crop Rotation.—Many fungi, bacteria, and other organisms, which cause plant diseases, attack only certain plants or their close relatives and soon die out in the soil if other crops are planted on the land. Frequent changing of crops on land affected with disease starves out the causal organisms or prevents them from increasing. This combined with other control methods keeps many disease losses at a minimum. Some of the parasites attack a wide range of hosts, such as the root-knot nematodes, or are capable of living in the soil for long periods of time, like many wilt-disease fungi. For control of these diseases special rotations are necessary, or other methods must be used.

Disinfection of Plant Parts—*Seed treatment.*—Where disease-resistant varieties are not available or disease-free seed can not be procured, seed treatment can be used to excellent advantage to prevent the introduction of seed-borne organisms, which are carried on the outside of seed or tubers. For example, most cases of angular leaf spot of cucumber can be controlled by seed treatment alone, but for effective control of potato scab, seed treatment must be combined with crop rotation.

Soaking the seed in solutions of mercuric chloride, formaldehyde, or certain organic mercury compounds, and hot-water treatment constitute the principal methods for seed tuber disinfection. Some disease organisms will die out on seed after a year or two, and the aging of the seed then becomes an effective fungicidal treatment provided the seed retains its viability for a longer period than required for the disease organism to die out.

Treatment of wounds.—Wounds are places of entrance for disease organisms. If trees have been subjected to severe ice or windstorms, remove all hanging branches promptly, generally by cutting at the break. If damage is severe, some or all of the main stubs may be left until growth starts sufficiently to show where strong buds or shoots will develop. Just above this point, remove ends of stubs with a slanting cut of about 45°. The developing bud or shoot must be at the peak of the cut. Saw off the stubs of branches close to the trunk, using precautions to prevent stripping bark and wood below the scar. Apply a coat of shellac to the cut edges of the sapwood, bark, and cambium within five minutes of the final trimming, or as soon as the surface becomes dry. Finally paint the cut surface with shellac or commercial creosote, followed by thick coal tar or asphalt for waterproofing. (16).

Treatment of fruits.—Treatment of harvested fruits, in some instances, is effective in preventing wastage in transit and storage. For example, soaking oranges in a 5 per cent borax solution at 120° F., and allowing the borax to remain after drying, will control blue-mold decay.

Soil Treatment—*General.*—Many disease-producing organisms, such as the root-knot nematode, fungi causing "damping off" of seedlings and smut of onions, live in the soil for considerable periods of time. Under certain conditions such soils can advantageously be treated to kill these organisms. For small areas, such as coldframes, hotbeds, greenhouse benches, and flats, various methods of applying steam or hot water directly from the greenhouse heating plant or from a portable boiler are available and have the advantage over other methods that they will kill weed seeds as well as disease organisms. The soil may be drenched with a formaldehyde solution where other more desirable means are not available. Solutions of mercuric chloride and other compounds containing mercury are also used for the same purpose. For use on a field scale, several methods are available, the formaldehyde drip treatment for onion-smut control being the most generally used. (54). Lime at the rate of 80 bushels per acre is also applied to infested fields to reduce losses from cabbage clubroot. The use of sulphur at the rate of 300 to 600 pounds per acre has caused a marked reduction in the amount of scab on potatoes in certain States. The quantity best suited to individual localities must be determined by trial.

Chemical.—Formalin drench: Use 1 gallon of formaldehyde to 50 gallons of water, and sprinkle this over the beds at the rate of 50 gallons to every 100 to 150 square feet of seed-bed surface, giving the solution time to soak into the soil to a depth of at least 4 inches. Give the soil several days to dry out so that all fumes of formalin have time to disappear before seed is sown. This method is unsatisfactory unless the application can be made a considerable time before sowing, since unfavorable weather for drying may delay sowing. Fall applications may sometimes be made advantageously.

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Heat.—Inverted pan: To steam beds by the inverted-pan method, a boiler, pan, and connecting hose or pipe are required. Boiler should have sufficient capacity to discharge a continuous flow of steam at a fairly high pressure into the inverted pan. Although the pressure in the pan itself may be considerably less than a pound, the advantage in high pressure lies in the fact that "dry" steam is preferable to "wet" steam, and in that more steam can be supplied to the pan per minute through a small connecting hose. The ordinary steam traction engine, when obtainable, is especially suitable for this work. Pan is preferably made of No. 16 galvanized iron reinforced with angle iron. It varies ordinarily from 50 to 100 square feet in area, 6 by 12 feet with a height of 8 inches being common. Iron pipe handles are ordinarily attached. Lower edge of pan should be sufficiently sharp so that it may be pressed readily into loose soil. Inlet of steam may be made through the top or side of pan, but should be so placed that the steam is not thrown directly into the soil.

Soil steaming for seed beds is usually done in the spring, some time before sowing the seed, although fall steaming is sometimes practiced with good results, especially where some protection can be given to the beds to prevent reinfestation with parasites and weed seeds. Seed beds should be made practically ready for sowing before sterilization. When steamed the soil should be fairly loose, not too dry nor too wet. Length of time required to sterilize the soil will depend largely upon its moisture content and its compactness; ordinarily 30 minutes of steaming suffices. Cost is usually between 1 and 1½ cents per square foot.

Soil in pots, flats, or other containers may be sterilized in home-constructed steam chambers of wood, sheet metal, or concrete. Steam sterilizers of various sizes up to processing kettles 6 feet deep and 40 inches in diameter can, of course, be purchased. They are usually too expensive for most farms, but often are found very useful in large greenhouses.

Surface firing: Consists in burning brush or other material on the surface of the seed bed for a period of 30 minutes to 1 hour. The roasting process consists in principle of shoveling about 4 inches of the surface soil of the seed bed upon an iron pan under which a fire is maintained, and heating it sufficiently to convert most of the moisture to steam before replacing it.

Spraying.—Control of numerous foliage diseases of truck and fruit crops by spraying should be made a regular part of farm practice. Simplification of methods of preparing spray materials and the increasing adoption of the plan of community spraying, have done much to enlarge the popularity of spraying, especially on the moderate-sized farms where the purchase of the most efficient type of high-pressure sprayer is too expensive for the individual farmer but quite possible for a group of near-by growers.

Dusting.—In the control of some fruit diseases dusting has been found preferable to spraying, but it has not to any great extent taken the place of spraying. Its principal uses at present seem to be for those diseases against which it has been found effective, and under circumstances where the extra cost of dust and its lower efficiency in disease control are more than offset by the rapidity of application and the reduced cost of labor. Greater convenience of dust applications for small areas is also an important consideration.

Fungicides

General.—Growers are advised to use standard fungicides where valuable crops are involved. Usually it is the safest policy to adhere to products that the State experiment station recommends. Experimentation may prove costly if carried out on a commercial basis by individuals. Care should be exercised in selecting and purchasing materials to make sure that the combinations of insecticides and fungicides used are compatible and will not result in injury to the plants on which they are to be used. Consult the following table of spray and dust combinations.

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Spray and dust combinations[1] *(See 8.73–.74)*

FUNGICIDES

Basic material	Contact sprays	Stomach poisons	Stickers, spreaders, neutralizers	Remarks
Bordeaux mixture	Nicotine sulphate			Not on peach.
	do		Soap	Do.
	do	Lead arsenate		Do.
	do	do	Soap	Not on truck crops, except cabbage; not on peach.
	do	Calcium arsenate		Not on fruits, especially stone fruits.
		Lead arsenate		Not on peach.
		Calcium arsenate		Not on fruits, especially stone fruits.
		do	Soap	Not safe on tender foliage.
Lime-sulphur concentrate.	Nicotine sulphate			Not on truck crops; not on peach.
	do	Lead arsenate		Do.
		do		Do.
Self-boiled lime-sulphur.	Nicotine sulphate			Use on stone fruits, not on vegetables.
		Lead arsenate	Casein	Do.

[1] Combinations containing soap and lime-sulphur, lead arsenate, Paris green, or calcium arsenate should be used with caution on tender foliage. The addition of casein does not alter any combination spray.

CONTACT POISONS

Basic material	Contact sprays or fungicides	Stomach poisons	Stickers, spreaders, neutralizers	Remarks
Lime-sulphur concentrate.	Nicotine sulphate			Not on truck crops; not on peach.
	do	Lead arsenate		Do.
		do		Do.
Nicotine sulphate	Lime-sulphur concentrate.			Do.
	do	Lead arsenate	Casein	Do.
	do	Calcium arsenate		Do not use.
	Bordeaux mixture		Casein	Not on peach.
	do	Lead arsenate		Do.
	do			Do.
	do	Calcium arsenate		Not on fruits, especially stone fruits.
		Lead arsenate	Milk of lime	
		do	Casein	
			Soap or casein	
		Calcium arsenate	Milk of lime	Not on fruits, especially stone fruits.
Nicotine sulphate dust	Sulphur			Contact insecticide and repellent.
Kerosene emulsion	Bordeaux mixture			Not on truck crops; not on peach.
Lubricating oil emulsion.	do			Combined dormant scale treatment and fungicide.
Do	Lime-sulphur and nicotine sulphate.		Casein	Dormant or delayed dormant treatment for scale, aphids, and fungi.

Spray and dust combinations (*See 8.73–74*)—Continued

STOMACH POISONS

Basic material	Fungicides	Contact sprays	Stickers, spreaders, neutralizers	Remarks
Lead arsenate	Bordeaux mixture			Not on peach.
	do		Soap	Not on tender vegetables.
	do	Nicotine sulphate		Not on peach.
	do	do	Soap	Not on tender vegetables.
	Lime-sulphur concentrate.		Milk of lime	Not on truck crops; not on peach.
	do	Nicotine sulphate		Do.
		do		
		do	Soap	Not on truck crops, except cabbage; not on peach.
			do	Use on cabbage; not on peach.
			Milk of lime	
		Nicotine sulphate	do	
	Finely ground[1] sulphur.			Used as dry dust.
Calcium arsenate		Nicotine sulphate	Milk of lime	Not on fruits, especially stone fruits.
	Lime-sulphur	do		Not on fruits, especially stone fruits; not on truck crops.
	Bordeaux mixture	do		Not on fruits, especially stone fruits.
			Milk of lime	Do.

Paris green	Bordeaux mixture			Not on fruits, especially stone fruits; not on tender vegetables.
	do	Nicotine sulphate		Do.
		do	Milk of lime	Do.
			do	Do.
		Nicotine sulphate		Do not use.

[1] Hydrated lime or gypsum are also used as diluents. They have no fungicidal value.

Spreaders—*Casein lime.*—Mixture usually referred to as calcium caseinate and sold under various trade names. Since the commercial products vary in the proportion of casein and lime used in their manufacture, the grower should dilute each according to instructions. A commonly recommended dilution is one which furnishes about one-fourth pound of casein to 100 gallons of the diluted spray. A homemade product may be prepared by the thorough mixing together of 1 part of a good grade of casein and about 2 parts of good hydrated lime. According to present information 1 pound of this mixture in 100 gallons of spray is a good dilution. Before adding to spray make into a paste by sifting the mixture slowly into a small quantity of water while beating vigorously with a wire beater made of wires looped together somewhat on the style of a carpet beater of suitable size.

Resin fish-oil soap.—Purchased ready for use as a spreader and sticker. Sometimes used with Bordeaux mixture or lead arsenate for certain smooth-leaved truck crops, such as onions, cabbage, and asparagus. Dissolve 2 or 3 pounds of the soap in a small quantity of water and add to 50 gallons of spray.

Resin.—For use as a spreader and sticker mix together 2 pounds of pulverized resin, 1 pound sal soda, and 1 gallon of water. Boil from one to one and one-half hours, until solution is a clear brown color. Add this solution to 50 gallons of diluted spray. Sometimes used instead of resin fish-oil soap with Bordeaux mixture or lead arsenate.

Lubricating-oil emulsion.—Recently introduced for the control of scale. May be used as a spreader for Bordeaux mixture. Use at the rate of one-half gallon of the stock emulsion to 50 gallons of the diluted spray. (See 8.7.)

Copper Sprays and Dusts—*Ammoniacal copper carbonate.*—Formula: Copper carbonate, 5 ounces; ammonia (26° Baumé), 2 to 3 pints; water to make 50 gallons. Dilute the ammonia with 7 or 8 parts of water. Add water to the copper carbonate to make a paste. Dissolve the copper carbonate paste with the diluted ammonia, using no more ammonia than is necessary to complete the solution, and then add the remaining water. Use as a substitute for Bordeaux mixture where necessary to avoid staining.

Bordeaux mixture.—Homemade: Made from the mixing of a solution of copper sulphate (blue vitriol) and milk of lime. A mixture made from 3 pounds of copper sulphate and 3 pounds of stone lime to 50 gallons of water is designated by the formula 3–3–50. If 4 pounds of each were used the formula would be 4–4–50. In some instances where necessary to prevent or reduce russeting of fruit or injury to foliage Bordeaux is prepared by the use of a larger proportion of lime than indicated in the above formulas. Some have found an excess as great as or greater than three times the quantity of copper sulphate (for example, a 3–10–50 formula) to be advantageous.

If the bluestone is in large crystals, prepare a stock solution of copper sulphate by dissolving it in water, 1 pound per gallon. To do this, suspend the bluestone in a gunny sack or small box in a wooden barrel or vessel, so that it is just beneath the surface of the water until it dissolves. Using rock lime, prepare a stock solution of lime, first slaking the lime by adding water slowly, then dilute until the stock solution contains 1 pound stone lime per gallon. Hydrated lime may be substituted for quicklime, provided 50 per cent more by weight is used in all formulas.

Various methods of mixing are used, and the quality of the mixture varies accordingly. A good method requiring no dilution tanks, when a power sprayer is used, is as follows: Fill the spray tank almost but not quite full of water, start the engine to furnish agitation, and add the stock bluestone solution. Then pour the stock lime solution slowly through the screen while the weak copper solution is also being pumped through the screen by the back flow from the pump. When all the lime has been added and thoroughly mixed, any arsenical that is desired can be added and the agitation continued a few moments longer. This method gives a Bordeaux mixture of good physical properties.

Another method is to dilute both the copper sulphate and the lime solutions to one-half the quantity required to fill the tank, and then pour the two solutions together. With a large sprayer this requires dilution tanks for the copper sulphate and the lime, and the two solutions can readily be poured together through the strainer in the spray tank by means of a large hose from each dilution tank. Reasonably cool water, about 54° F., makes a better Bordeaux than warmer water.

If granulated bluestone and hydrated lime are used, stock solutions may be dispensed with entirely, the procedure then being as follows: Use granulated bluestone, about the size of granulated sugar. Place the required quantity for a spray tank in a sieve in the opening or in a coarse sack suspended inside the tank. Fill with water, and by the time this is done the bluestone will be dissolved. Start the agitator and sift in builders' hydrated lime, at the rate of 1½ pounds for each pound of bluestone used.

Bordeaux-oil emulsion: Make by adding oil emulsion to Bordeaux mixture while the agitator is running. Three gallons of oil emulsion (Government formula or its equivalent) in 200 gallons of Bordeaux mixture gives 1 per cent of oil, since the formula requires 2 gallons of the paraffin oil in 3 gallons of emulsion.

Bordeaux paste: Dissolve 1½ pounds bluestone in 1 gallon of water. Slake 3 pounds of quicklime in 1 gallon of water. Mix together in equal quantities as needed for use.

Commercial Bordeaux (60): Commercial Bordeaux pastes and powders are sold as such and under various proprietary trade names. Their value varies according to their copper content and their physical properties. Their percentage of copper is stated on the label, and from this can be calculated, by the method illustrated in the following example, what the formula of the Bordeaux produced will be when diluted as directed on the label. The percentage of metallic copper multiplied by 3.93 determines the equivalent percentage of copper sulphate (bluestone). For example, a commercial Bordeaux paste which has been examined contains 11 per cent of metallic copper, according to the analysis given on the label. Therefore, if the preparation contains 11 per cent of copper, it contains the equivalent of 43.23 per cent of crystallized copper sulphate (obtained by multiplying 11 per cent by the factor 3.93, which is 43.23 per cent). The label recommends that 10 pounds of this mixture be diluted with 50 gallons of water. Therefore, in order to calculate the quantity of crystallized copper sulphate in 50 gallons of the diluted spray, take 43.23 per cent of 10 pounds, which equals 4.32 pounds, the equivalent of copper sulphate in 50 gallons of the spray.

For quick reference, without making the exact calculations, consult the following table, which gives the

equivalent percentages of copper sulphate and number of pounds of concentrated commercial mixtures necessary to use in order to make Bordeaux mixtures of given formulas.

Bordeaux mixture: Comparison table

Metallic copper given on label (per cent)	Equivalent copper sulphate (per cent)	Pounds of concentrated mixture necessary to add to 50 gallons of water to make formula.			
		2-2-50	3-3-50	4-4-50	5-5-50
1.5	5.89	33.9	50.9	67.8	84.8
2	7.86	25.4	38.2	50.8	63.6
2.5	9.82	20.3	30.5	40.7	50.9
3	11.79	16.9	25.4	34.0	42.4
4	15.72	12.7	19.1	25.4	31.8
5	19.65	10.2	15.2	20.3	25.4
6	23.58	8.4	12.7	16.9	21.2
7	27.51	7.2	10.9	14.5	18.1
8	31.44	6.3	9.5	12.7	15.9
10	39.30	5.1	7.6	10.2	12.7
12	47.16	4.2	6.3	8.5	10.6
15	58.95	3.4	5.1	6.8	8.6
18	70.74	2.9	4.3	5.7	7.1
20	78.60	2.6	3.9	5.1	6.4
22	86.46	2.4	3.5	4.7	5.8

Testing Bordeaux: It is important that any Bordeaux should contain sufficient lime to neutralize all soluble copper, otherwise serious injury may result. Where the quality of lime is questionable or where for any reason the safety of a mixture, either homemade or commercial, is questionable, the following test should be made: To test for soluble copper, allow 1 or 2 drops of potassium ferrocyanide solution to fall on the Bordeaux mixture. If the drop remains yellow no copper is present in solution. If a brownish precipitate is formed more lime should be added. A test for physical properties may be made if a glass cylinder is filled with some of the mixture and allowed to stand for a time. If the precipitate settles very rapidly it indicates a poor mixture. A good fresh Bordeaux, properly made, stands up well.

Burgundy mixture.—Sometimes used as a substitute for Bordeaux where necessary to avoid the staining of fruit or foliage. A common formula calls for 2 pounds copper sulphate (bluestone), 3 pounds sodium carbonate (sal soda), and 100 gallons of water. It sometimes is used much stronger than this on certain hardy plants. Stock solutions may be prepared and the mixing done in the same manner as described for Bordeaux, except that the sodium carbonate should be substituted for the lime.

Copper acetate.—Dissolve 6 ounces to 1 pound of dibasic or neutral acetate of copper in 50 gallons of water. Is used for the same purpose as ammoniacal copper carbonate.

Copper-sulphate lime dust.—Factory product consisting of a mechanical mixture of monohydrated copper sulphate and hydrated lime variously proportioned according to use. If applied as a dust in the presence of sufficient moisture, the ingredients combine chemically

to form Bordeaux mixture on the plant. It probably should be applied while plants are wet with dew or other moisture for best results. Application when plants are dry may result in the lime carbonating, failure to form Bordeaux, and subsequent injury from the soluble copper sulphate.

Other Copper Preparations—*Copper-sulphate lime for cereal seed.*—Dissolve the copper-sulphate crystals in water at the rate of 1 pound to each 5 to 10 gallons of solution desired. Crystals dissolve best if suspended in a porous cloth or bag in the water. A solution containing 1 pound of copper sulphate to 10 gallons of water is used more commonly. One pound of quicklime is used for each 10 gallons of lime water used. Slake the lime in a sufficient quantity of water to cause it to slake readily, and add enough water to bring it up to the desired volume.

Place the grain in porous bags, fill them about half full, dip them in the copper-sulphate solution, and let them remain until the grain is thoroughly wet. Ten minutes is not too long to soak, if a 1-pound to 10-gallon solution is used. Another method used is to pour the loose grain into the copper-sulphate solution and skim off the trash and smut balls which rise to the top. The solution is drained off as soon as the grain is thoroughly wet. After removing the grain from the copper sulphate solution dip it into limewater and allow it to remain until thoroughly wet. Then remove it and spread it out to dry.

Copper carbonate.—May be used for control of bunt in wheat and the kernel smuts of sorghum. A good basic copper carbonate containing about 50 to 52 per cent of copper and not more than 67 per cent of impurities is considered best. It should be ground sufficiently fine to pass through a 200-mesh sieve when suspended in water. Powder should not weigh more than 32 pounds per cubic foot when shaken down thoroughly. It should be bright green, never blue in color. "Coppercarb," a compound containing about 18 to 20 per cent of copper mixed with inert material, has been used successfully, but in many cases a slightly heavier application of this diluted copper carbonate has been required than is needed of the pure form in order to get the same results.

Use 2 to 3 ounces of copper carbonate per bushel of wheat. The copper carbonate must be spread evenly over each seed. Do this by thoroughly mixing the grain and the dust in a tightly closed mixer. Copper carbonate sifts into all parts of the grain drill. After the drill has stood over night, turn the feed shafts with a wrench to start the feed wheels. This avoids possible gear breakage. Oil the gear bearings frequently. Do not leave treated grain in drill over night.

WARNING.—Copper is poisonous. (1) Wear a mask over the nose and mouth when treating grain with copper-carbonate dust. (2) The treating should be done in a well-ventilated place. (3) Do not use or sell treated wheat for food or feeding purposes.

Sulphur Sprays and Dusts—*Self-boiled lime-sulphur.*—Formula: Eight pounds sulphur, 8 pounds quicklime, 50 gallons of water. Place lime in barrel, pour over it enough water, preferably warm, to start slaking. As slaking begins add sulphur and stir. Add water from time to time to keep mixture from becoming dry, but not sufficient to stop boiling. After lime has about finished slaking and before the red streaks begin to ap-

pear to any extent in the mixture, add sufficient water to make 50 gallons. The sulphur should be worked through a screen to eliminate all lumps before the sulphur is added.

Dry mix.—Mixture of sulphur and lime made "wettable" by the addition of a casein-lime spreader. Formula: Superfine dusting sulphur, 8 pounds; fresh hydrated lime, 4 pounds (when used with lead arsenate on stone fruits the amount of lime should be doubled); casein-lime spreader, 8 ounces. Sift sulphur through a 12 or 14 mesh screen. Mix the above ingredients together uniformly. Dilute 12½ pounds to 50 gallons of water. Used principally as a substitute for self-boiled lime-sulphur.

Precipitated sulphurs.—Known as pastes containing free sulphur in a very finely divided form obtained by various methods of precipitation from soluble sulphides. Sold under various trade names ready for dilution with water according to directions.

Sulphur dusts.—Use only a very fine sulphur guaranteed at least to pass 95 per cent through a 200-mesh sieve. May be purchased already mixed with lead arsenate and hydrated lime, or any ingredients desired, according to the purpose for which it is used. The sulphur and other desired ingredients may be purchased separately and mixed with a mixing machine. The formulas for use will vary according to the purpose. For example, a mixture for dusting peaches may contain 80 per cent sulphur, 5 per cent lead arsenate, and 15 per cent hydrated lime, or the proportions may be varied to suit the circumstances. Sulphur alone does not possess suitable dusting properties, so if no lead is to be used in mixture, from 5 to 10 per cent of hydrated lime should be added to the sulphur to make it "flow" properly.

Barium sulphides.—Purchased in powdered form to be dissolved in water. Sometimes used as a substitute for lime-sulphur solution. Results obtained by the United States Department of Agriculture with barium sulphides have not, in general, compared favorably with those from lime-sulphur solution.

Dry-lime sulphur.—Prepared from lime-sulphur solution by elimination of the free water content, which reduces the bulk and weight of the material for shipment and handling. The dry powder is dissolved in water and used as a substitute for lime-sulphur solution. Tests indicate that in the treatment of certain diseases, the dry powder should be used at a strength chemically equivalent to that of the solution in order to insure results equal to those obtained with the lime-sulphur solution. For example, dry-lime sulphur containing 65 per cent calcium polysulphides and 12 per cent free sulphur, in order to compare favorably with a summer strength of lime-sulphur solution (testing 32° Baumé diluted 1½ to 50) should be diluted approximately 6 pounds to 50 gallons of water.

Lime-sulphur solution.—May be purchased ready for dilution with water according to the specific diseases against which it is to be used, or it may be prepared at home by following directions under Entomology. (See 8.7.) The standard commercial product usually tests about 33° Baumé, and all recommendations for dilution are based on a product of this strength. Since the homemade product will vary it is necessary to test it with a Baumé hydrometer and dilute according to its strength.

Potassium sulphides.—Known as potassium sulphide, sodium sulphide, or polysulphides. Can be purchased under various trade names, either in powdered form or in solution ready for dilution with water. Caution:

Can not be used with lead arsenate on foliage without serious injury.

Sodium sulphides.—See Potassium Sulphides.

Sulphur (Other than Spraying).—Fumes from sulphur have fungicidal value. Sulphur may be sprinkled about the plants in hothouses with beneficial results.

Mercuric Preparations—*Corrosive sublimate.*—Known chemically as mercuric chloride. May be used for treating seed potatoes and seeds of cucumber, cabbage, and other vegetables to prevent diseases. Use 1 part corrosive sublimate to 1,000 parts of water. This is equivalent to two large tablets of corrosive sublimate to 1 quart of water, or 1 ounce of corrosive sublimate to 8 gallons. Corrosive sublimate is a deadly poison. Use only wooden or earthenware vessels, since metal containers are destroyed by it.

Organic mercury compounds.—Chlorophenol-mercury compounds, including Chlorophol, Uspulun, and Semesan, of which the last two are products now being handled commercially in the United States, have been used in experimental work in this country for the last four years. In addition to these compounds, Germisan, a cyancresol-mercury compound, and Corona No. 620, an orthonitrophenol mercury, are on the market. The above preparations are used in liquid form. A number of related mercury compounds are now being prepared for use in dust form. Although favorable results have been obtained in many tests of the organic mercury compounds, it is of course necessary to try these materials before they can be generally recommended. It would seem that they have possibilities of giving excellent results for the control of seed-borne diseases, but as yet they are probably not beyond the experimental stage. The use of such compounds as plant stimulants is, even more definitely, still in the experimental stage.

Formaldehyde.—Commonly known as formalin. It is used for treating seed potatoes or soil to prevent diseases. Use at the rate of 1 pint of formalin to 30 gallons of water. This is equivalent to 1 teaspoonful of formalin to 1 quart of water, or 1 ounce to 2 gallons. For onion-smut control, use 1 ounce of formalin to 1 gallon of water.

Hot Water—*Cereals.*—Hot-water treatment may be used for control of loose smuts of wheat and barley. It is recommended only for treating seed which is to be sown for the purpose of growing clean seed. It is too tedious and causes too much injury to be recommended for application generally. Smut-free areas can be established if all seed sown in a few adjoining fields is treated and the seed grown in these fields used to sow in the surrounding territory the following season. This can best be done by community cooperation. There are two methods of treating wheat with hot water: (1) Modified hot-water method, which consists in presoaking the seed for 4 or 5 hours in cold water, dipping momentarily in water at about 120.2° F., and immersing in water at 129.2° F. for 10 minutes. Spread the seed in a thin layer to cool, and let it dry before sowing. (2) Soak the seed in water at 118.4° F. for 1 hour and 50 minutes, or at 120.2° F. for 1 hour and 45 minutes. This treatment does not seriously reduce or retard germination, and the yields are reduced less than by the modified hot-water treatment.

The hot-water treatment is not necessary for control of loose smut in six-rowed barleys, at least in the northeastern United States, where formaldehyde and some of the chlorophenol-mercury compounds have given satis-

factory results. It is the only satisfactory method for loose-smut control in two-rowed barleys, however. The hot-water treatment generally recommended for barley is as follows: Presoak the seed from four to six hours in cold water and soak for 10 to 15 minutes in hot water at 125.6° F. Spread the seed out to cool and dry before sowing. Even this treatment causes considerable injury to seed of some varieties.

Cabbage.—Hot-water treatment may be used for control of cabbage blackleg. When seed is known to be entirely free from blackleg the mercuric-chloride treatment will be sufficient to eliminate the black-rot organism. When seed is known to be infected with blackleg or its conditions as to infection are unknown the hot-water treatment may be used. It will control blackleg completely, but will reduce somewhat the percentage of germination, particularly if the seed is old or badly shriveled. Use this treatment cautiously and, if possible, make preliminary trials to determine its effect on germination of a given lot. For handling lots of 5 pounds or less proceed as follows: Place the seed on the center of a square piece of coarse cheesecloth so large that when the edges are drawn together and tied the improvised sack will be not more than one-third full. Provide a large vessel containing water adjusted to exactly 122° F., a thermometer, and a stirring rod. Immerse the seed bag, agitate the seed thoroughly, and stir the water slowly. Keep the temperature of the water approximately constant by adding steam or boiling water whenever the thermometer registers below 122° F. Remove the seed bag for an instant as the water or steam is added. Soak for 30 minutes. Remove to cold water, drain, and spread out to dry.

Machinery

Spraying (5).—A number of companies are manufacturing spray apparatus suitable for almost every purpose from the spraying of a few plants in the home garden to use in commercial orchards or fields. Bucket pumps, small compressed-air sprayers, knapsack sprayers, wheelbarrow sprayers, barrel pumps, field traction sprayers, and power sprayers all have their uses. In preparing for spray operations order supplies carefully to provide for emergencies. Extra lengths of hose, spray nozzles, and parts that are apt to be lost or broken should be kept on hand. When the spray season is over clean the equipment thoroughly and grease and oil parts that need attention. Proper storing of the spray machine means money saved. Information as to details of construction can be obtained from a study of catalogues published by several manufacturers.

Dusting.—Dusting equipment for almost any purpose can now be found on the market. For the home garden, hand shakers, small bellows dusters, and a somewhat larger bellows type built to be carried on the back are in common use. This latter type is equipped with a flexible discharge tube, which makes it convenient for dusting young trees. Plunger dusters are also sold for work on a small scale. The crank or fan-blower hand duster is used rather generally. The fan-blower type is built on a larger scale in the traction-driven and power dusters. Information as to details of construction can be procured from catalogues published by manufacturers. Discuss the matter with your State extension entomologists and pathologists.

Seed Treatment.—In practically all seed-treatment work, once the principle of the treatment is understood, farmers have shown considerable ingenuity in developing home-

made machinery to lighten the work. In many instances pictures of various devices that have been used successfully are on file in the office of the State extension pathologist, and information concerning these can be obtained from him. Many homemade machines for treating seed wheat with copper carbonate have been developed by farmers. A very good type consists of a cubical box of any desired size with a shaft extending diagonally from one corner to another and mounted on a frame. A door is built at one corner, and the machine is turned by hand.

Several machines for applying copper carbonate are now on the market. These are power driven, having a continuous feed for the copper carbonate, and are capable of treating 100 to 250 bushels per hour. One machine built for use in treating seed potatoes with formaldehyde has a large insulated tank which is heated by gasoline burners and will take 4 bushels at one time. The tank is equipped with an alarm clock which rings when the potatoes have been in the solution for two minutes.

Soil Treatment.—See .817.

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SOILS

SOIL SCIENCE

Parent Material Accumulation

Soil, in the true sense of the word, and the soil material or the parent material of the soil, should be clearly distinguished by everyone who approaches the subject from either the scientific or practical point of view. The parent material is a geological formation, whereas the soil is not, although the difference between the two varies from a minimum where the two are essentially identical to a maximum where they are widely different. Before a soil can develop, soil material must be accumulated. This accumulation is a geological process, and when the material has been accumulated, but before any changes have been impressed on its material, it may be described as embryonic soil. This process may take place (1) by deposition from air, water, and ice, and (2) by disintegration of consolidated rocks.

Soil Making.—Soil is produced by soil-making processes acting upon this accumulation. The result of this action is to produce a body of material, the true soil, differing more or less widely but distinctly from the soil material underlying it.

Soil Description.—In its earliest stages the soil layer is very thin and differs from the geological formation beneath it, the soil material. This layer increases in thickness as development proceeds, varying from nearly 2 feet in regions with a cool climate to 8 or 10 feet in regions having a hot, moist climate.

Zones.—In addition to an increase in thickness of the soil layer as a whole, it has become zonated or developed into well-defined layers or horizons which lie parallel to the surface. Several layers or zones may be formed differing from one another, but on the basis of their fundamental character they may be grouped into two major zones, each having a number of subordinate zones.

(1) The zone of extraction or eluviation is the upper or surface zone, from which mineral matter is being eliminated by the soil-forming processes.

(2) The zone of accumulation or illuviation is the one to which mineral matter, and in some cases organic matter, is being added.

The upper part of the geological material that has not been modified by the soil-making processes, except through imperfect oxidation and some leaching of carbonates or other salts in regions of heavy rainfall, is usually included as one of the soil horizons.

The eluvial horizon is usually designated as the A horizon, the illuvial horizon as the B horizon, and the upper part of the parent material as the C horizon. The A horizon is, when well developed, a lighter-textured horizon, whereas the B horizon is a heavier-textured horizon when compared with the texture of the C horizon, or the parent material.

Soil Classification

Texture.—This refers to the quality imparted to a soil by virtue of its content of the various sizes of soil particles, namely, fine gravel, coarse sand, medium sand,

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fine sand, very fine sand, silt, and clay. On the basis of the ratio existing between these standardized particles, a number of soil classes are used in the system of classification employed. The proportions of the particles of different sizes in the several soil classes are given as percentages in the table below:

Classification of soil material by textures

Soils containing less than 15 per cent silt and clay:	
Coarse sand	35 +[1] fine gravel and coarse sand, and less than 50 of other grades.
Sand	35 + fine gravel, coarse sand, and medium sand, and less than 50 fine sand.
Fine sand	50 + fine sand and less than 35 fine gravel, coarse sand, and medium sand.
Very fine sand	50 + very fine sand.
Soils containing 15 to 20 per cent silt and clay:	
Loamy coarse sand	35 + fine gravel and coarse sand, and less than 45 of any other grade of sand.
Loamy sand	35 + fine gravel, coarse sand, and medium sand, and less than 45 fine sand.
Loamy fine sand	50 + fine sand and less than 30 fine gravel, coarse sand, and medium sand.
Loamy very fine sand	50 + very fine sand and less than 30 coarse, medium, and fine sand.
Soils containing 20 to 50 per cent silt and clay, less than 50 per cent silt, and less than 20 per cent clay:	
Coarse sandy loam	45 + fine gravel and coarse sand.
Sandy loam	25 + fine gravel, coarse sand, and medium sand.
Fine sandy loam	50 + fine sand, or less than 25 fine gravel, coarse sand, and medium sand.
Very fine sandy loam	35 + very fine sand.
Soils containing more than 40 per cent sand and more than 20 per cent clay:	
Sandy clay loam	20 to 30 clay, less than 40 silt, 40 to 80 sand.
Sandy clay[2]	30 to 45 clay, less than 15 silt, 55 to 70 sand.

[1] The figures represent per cent; the plus sign "more than"; the minus sign "less than."

[2] In the soil survey very little use has been made of the term "sandy clay" as a type texture. The term has been employed largely as a descriptive designation.

Soils containing 50 per cent or more of silt and clay:

Loam	—20 clay, 30 to 50 silt, 30 to 50 sand.
Silt loam	—20 clay, more than 50 silt, less than 50 sand.
Clay loam	20 to 30 clay, 30 to 50 silt, 20 to 40 sand.
Silty clay loam	20 to 30 clay, 50 to 80 silt, less than 30 sand.
Clay	30+ clay, less than 55 silt, less than 55 sand.
Silty clay	30 to 45 clay, 45 to 70 silt, less than 15 sand.

Definition of particles.—According to the method of mechanical analysis employed by the Bureau of Soils, United States Department of Agriculture, seven separations are made in analyzing soils. The size limits and conventional names of these grades are as follows:

Analysis of soils

Conventional name	Diameter (millimeters)	Conventional name	Diameter (millimeters)
Fine gravel	1 to 2.	Very fine sand	0.1 to 0.05.
Coarse sand	1 to 0.5.	Silt	0.05 to 0.005.
Medium sand	0.5 to 0.25.	Clay	0.005 to 0.
Fine sand	0.25 to 0.1.		

Soil Series.—A soil series is a group of soils whose surface layer may range in texture from sand to clay, but which are alike in all other respects in soil, subsoil, and substratum. Such a group of soils is designated in this country by some geographic term, usually the name of the county or the town in which the first member of the group was identified.

Example.—The soils of Orangeburg series are characterized by the following layers from the surface downward:

(1) A thin surface layer of relatively light-textured material containing more or less organic matter, usually not thoroughly assimilated with the mineral matter. This horizon ranges in thickness up to about 3 inches.

(2) A light-colored relatively light-textured layer with a low content of organic matter. This horizon ranges in thickness up to a little more than 2 feet.

(3) A pronounced red relatively heavy layer, usually of mixed sand and clay, friable in consistency, uniformly colored, and free from tendency to compaction. This horizon ranges in thickness up to 4 feet.

(4) A substratum of unconsolidated sands, sandy clays, or silts, varying in color and consistency. These constitute the parent geological material from which the soils have developed. They extend downward to indefinite depths.

All the horizons, including the upper part of No. 4, are free from carbonates or other readily soluble salts, regardless of the character of the deeper parts of No. 4. The latter may or may not contain a considerable percentage of lime carbonate.

Soil Type.—A soil type as it is indicated on a soil map represents soil which has essentially identical characteristics throughout the area or areas indicated.

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Nomenclature.—A soil series is given a geographic name, usually the name of the county in which the series was first identified and described. The characteristics of the soil profile at this place are usually considered as typical of the series wherever it is mapped. In the progress of soil investigation it has been found necessary, however, to split formerly defined and established series and form other series. In some cases the former name has been retained for a series whose typical characteristics are not to be found in the locality where the name was first applied.

A soil type is given a double name. The first part of the name is that of the series in which the soil in question belongs, the other part designating the texture of the upper part of the soil. Example: Miami silt loam is a soil which has a profile like that of the members of the Miami series, and the upper or surface 6 inches or more has a silt-loam texture. A group of similar soils is designated, therefore, somewhat like a group of similar plants.

Soil Province.—This expression is now used as a convenient geographic designation for a region in which the predominant soils are similar. It differs in two important respects from the meaning given the term until a relatively short time ago. The term formerly referred to a region in which the geological formations were alike, either in petrographic character or in the geological processes by which the unconsolidated material from which the soil had been developed was accumulated in the locality where the soil is now found.

It is now clearly recognized that such a region was not in reality a soil province, but a geological province instead, and that if any province of this kind coincided with a soil province the coincidence was accidental.

The region was formerly regarded also as having a kind of taxonomic importance, and the soils within a given province were classified in different groups from the soils of any other province. This attitude was maintained until a great deal of actual soil knowledge had been accumulated by the study of soils in the field. Until this had been done it was not possible to classify soils according to soil characteristics, yet it was necessary to construct some kind of scheme for grouping soils while the work of accumulation was being performed. Now that a great deal of information about soils as such has been accumulated, it has become possible to base a scheme of classification on them regardless of geographic position, so that the province has lost its taxonomic significance. As now used it refers to a region in which the characteristics of the predominant soils are alike and different from the predominant soils in some other region, but it does not mean that there is no soil within the area of any given province exactly like a soil in the area of another.

Soil provinces as now defined differ to a considerable extent from what they were under the former geological definition. There are, for example, a Great Lakes province, a Midlatitude province lying east of the prairies and south of the Great Lakes province, a Southeastern province, a Prairie province, an Eastern Great Plains province, and a Western Great Plains province. The Mountain and Pacific Coast States have a great number of small provinces.

Each province may be subdivided into two or more subprovinces according to soil characteristics, and the provinces east of the Rocky Mountains may be grouped into soil regions.

Soil Region.—A soil region is an area of country which includes all soils that are alike in some one important characteristic. In the United States there are two soil regions, an eastern and a western. The eastern includes soils in which a normal or well-developed stage has been attained, and which are characterized by the presence of a zone of sesquioxide accumulation on some horizon of the soil section and the absence of carbonates from any horizon of the soil section, regardless of the nature of the parent rock.

The western region includes soils which in the normal stage of development are characterized by the presence on some horizon of the soil profile of a zone of accumulated salts of the alkalies or alkaline earths, regardless of the nature of the parent rock.

The above is the meaning of the expression soil region as it is now used. It was formerly used to designate a region in which there was a complex of soil provinces as the latter were then defined.

Soil Surveying

Object.—The object of soil surveying is to determine the distribution and boundaries of the areas of soil types, to project these areas upon maps of appropriate and convenient scale, to prepare a report describing the soil types mapped, and to summarize the results of the investigation.

Method.—Soil maps are made directly in the field; that is, the actual sketching of the soil boundaries goes forward with the work of identifying and locating the soil types.

The project unit in most parts of the United States is a county. In each county or project area the field party usually consists of two or four men, with an experienced soil-survey man in charge. The party is furnished with conveyance, usually a small automobile or motor truck, equipped with a specially constructed odometer for measuring and recording distances.

In areas for which there is no accurate base map these measurements taken along roads are used in the construction of a base map that shows all salient natural and cultural features, such as streams, roads, railroads, and houses, as well as the soil boundaries.

For the determination of the soil units and their areas and boundaries each man in the soil-survey party must examine the soil profile in many places, often at intervals of only a few hundred feet. The necessary examinations are made by means of a soil auger, about 1½ inches in diameter and 3½ to 6 feet or more long, depending upon the thickness of the soil section in the region; pick and spade for obtaining fresh exposures in cuts and ditches; hydrochloric acid to test for lime; and an outfit for determining soil acidity or alkalinity.

The plotting of the soil-unit areas and boundaries is accomplished by sketching directly upon the base map, distances being measured along roads by means of the odometer and through fields by pacing. Colors, number, or letter symbols are used to indicate the soil types on the map.

Sampling—*Method.*—A representative sample is taken of each soil type within an area. The location for taking the sample is carefully chosen as representative of the topography drainage, vegetation, and other external features associated with the type. A virgin or undisturbed condition of the surface is necessary. A trench some 6 feet long and 3 feet wide is dug sufficiently deep to expose all the soil horizons down to and including the un-

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weathered parent material. Each horizon is carefully observed, measured, and described in place, then a sample is taken of each distinct horizon, placed in sacks or small boxes, labeled, and shipped to the Bureau of Soils at Washington. The quantity of soil taken as a sample from each horizon varies with the purpose for which it is to be used, but is generally about 1 quart or 5 pounds.

Object.—The samples are used as aids in visualizing the soil type as a whole, in comparing it with other types or similar types in different localities for purposes of correlation. They are further used for mechanical and chemical analyses and other laboratory investigations.

Report.—The soil survey of an area needs for its interpretation and presentation a report carrying a description of the soils, a discussion of their economic relations, and a statement of their agricultural possibilities. These subjects are treated in the usual soil-survey report in a conventional manner.

A chapter is devoted to a general description of the area, its location, topographic features, regional drainage, towns, transportation, market facilities, and the character, source, and distribution of the population.

The chapter on climate deals briefly with the climatic features and their relation to the agriculture of the region.

The chapter on agriculture includes a brief history of the agriculture of the area and the treatment to which the soils have been subjected in the past. The present systems of agriculture are discussed and the relation of the crops grown and the methods of cultivation to the soil type are brought out.

The chapter on soils begins with a discussion of the general characteristics of the soils of the region. Descriptions of the profiles of the principal soils of the area are then given, and the classification of the soils into groups made by the soil survey on the basis of their characteristics is explained. The various soils are compared and the differences between them are brought out; the soil-forming processes which have acted upon various kinds of parent rock to bring about these differences are explained as far as they have been determined. This general discussion is followed by brief descriptions of the broad groups or series of soils. This chapter on soils is a treatise on the characteristics, origin, and classification of the soils of the area, and it must necessarily be somewhat technical.

The chapter on soils is followed by a detailed description of each soil type, its profile, minor variations, topography, and conditions of drainage. The present system of agriculture, crops, fertilizers, and land values, as well as the future possibilities of the type and recommendations for the treatment of the soil, are among the topics considered under the type description.

Map.—The map which accompanies the soil-survey report is designed to show the area occupied by each soil type and its distribution in the area. This map, as already mentioned, consists of a base showing the natural features, including the streams and bodies of water, marshes, and prominent elevations, and the artificial features, such as roads, railroads, towns, houses, and ditches.

The map is published on a convenient scale, the usual scale of the county maps of the Bureau of Soils of the United States Department of Agriculture being about 1 inch to the mile. The principal soil types are represented by color, and the minor differences in the soil type and feature of topography and drainage are often shown by crosshatching or symbols.

Distribution of Soil Reports

The total Federal edition of soil reports is 4,000 copies; 2,000 to the Congressman of the district, 500 to each of the two Senators of the State, and 1,000 to the United States Department of Agriculture. The entire congressional membership does not receive a quota of these reports, but only the Member from the district in which the area surveyed lies. It is assumed that the Congressman's quota will be placed almost entirely in the hands of the residents of his district, and that the Senators' quotas will go largely to the State in which the survey lies. The department's small edition is therefore husbanded carefully to meet the demands from the country in general, but as long as the supply lasts no reasonable request for copies of these reports is refused, whether it comes from within or without the district concerned. When the editions have become exhausted, the reports may be consulted in the important libraries of the country.

Detailed Soil Surveys

The following list gives the areas that have been covered by detailed soil surveys. Most of the areas consist of a single county, but some include only a part of a county or parts of several counties. The maps are drawn on a scale of 1 inch to the mile. This scale is large enough to show areas as small as 10 acres, but it is impracticable to show all the variations occurring in soils unless a map of very much larger scale be used. The reports accompanying the soil maps minimize this deficiency by describing the important soil variations which it is found impracticable to map as soil types or phases of soil types. In some of the surveys the field work has been completed, but the reports are in process of publication and are not yet available for distribution.

Alabama.—Autauga, Baldwin, Barbour, Bibb, Blount, Bullock, Butler, Calhoun, Chambers, Cherokee, Chilton, Choctaw, Clarke, Clay, Cleburne, Coffee, Colbert, Conecuh, Covington, Crenshaw, Cullman, Dale, Dallas, Dekalb,[1] Elmore, Escambia, Etowah, Fayette, Franklin, Geneva, Greene, Hale, Henry, Houston, Jackson, Jefferson, Lamar, Lauderdale, Lawrence, Lee, Limestone, Lowndes, Macon, Madison, Marengo, Marion, Marshall, Mobile, Monroe, Montgomery, Morgan, Perry, Pickens, Pike, Randolph, Russell, St. Clair, Shelby, Sumter, Talladega, Tallapoosa, Tuscaloosa, Walker, Washington, Wilcox.

Arizona.—Cochise,[1] Graham,[1] Maricopa,[1] Navajo,[1] Pinal,[1] Yuma.[1]

Arkansas.—Arkansas,[1] Ashley, Baxter, Benton,[1] Bradley, Clay, Columbia, Conway, Craighead, Drew, Faulkner, Hempstead, Howard, Jefferson, Logan, Lonoke, Miller, Mississippi, Nevada, Perry, Pope, Prairie, Pulaski, Washington,[1] Yell.

California.—Alameda,[1] Butte,[1] Colusa,[1] Contra Costa,[1] Eldorado,[1] Fresno,[1] Glenn,[1] Humboldt,[1] Imperial,[1] Kern,[1] Kings,[1] Lassen,[1] Los Angeles,[1] Madera,[1] Mendocino,[1] Merced,[1] Modoc,[1] Monterey,[1] Nevada,[1] Orange,[1] Placer,[1] Riverside,[1] Sacramento,[1] San Benito,[1] San Bernardino,[1] San Joaquin,[1] San Luis Obispo,[1] Santa Barbara,[1] Santa Clara,[1] Santa Cruz,[1] Shasta,[1] Siskiyou,[1] Sonoma,[1] Stanislaus,[1] Sutter,[1] Tehama,[1] Tulare,[1] Yolo,[1] Yuba.[1]

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[1] Part of county.

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Colorado.—Bent,[1] Conejos,[1] Costilla,[1] Delta,[1] Larimer,[1] Mesa,[1] Montrose,[1] Otero,[1] Ouray,[1] Prowers,[1] Rio Grande,[1] Saguache,[1] Weld.[1]

Connecticut.—Hartford,[1] New London, Tolland,[1] Windham.

Delaware.—Kent, New Castle, Sussex.

Florida.—Alachua,[1] Bradford, Brevard,[1] Citrus,[1] Dade,[1] Duval, Escambia, Flagler, Franklin, Gadsden, Hernando, Hillsborough, Jackson,[1] Jefferson, Lake, Leon, Levy,[1] Marion,[1] Orange, Palm Beach,[1] Pinellas, Putnam, St. Johns, St. Lucie,[1] Sumter.[1]

Georgia.—Ben Hill, Bibb, Brooks, Bulloch, Burke, Butts, Calhoun, Carroll, Chatham, Chattahoochee, Chattooga, Clay, Cobb, Colquitt, Columbia, Coweta, Crisp, Decatur,[1] Dekalb, Dodge, Dooly, Dougherty, Early, Fannin, Fayette, Floyd, Franklin, Glynn, Gordon. Grady, Greene, Habersham, Hancock, Henry, Houston,[1] Jackson, Jasper, Jeff Davis, Jenkins, Jones, Lamar, Laurens, Lee, Lowndes, Macon,[1] Madison, Meriwether, Miller, Mitchell, Monroe, Morgan, Muscogee, Newton,[1] Oconee, Pierce, Pike, Polk, Pulaski, Putnam, Rabun, Randolph, Richmond, Rockdale, Screven, Spalding, Stewart, Sumter, Talbot, Tattnall, Terrell, Thomas, Tift, Troup, Turner, Walker, Walton,[1] Ware,[1] Washington, Wilkes.

Idaho.—Ada,[1] Bannock,[1] Bingham,[1] Canyon,[1] Cassia,[1] Fremont,[1] Kootenai, Latah, Lewis, Lincoln,[1] Minidoka,[1] Nez Perce, Twin Falls.[1]

Illinois.—Calhoun,[1] Clay, Clinton, Jo Daviess, Johnson, Knox, McLean, Sangamon, St. Clair, Tazewell, Will, Winnebago.

Indiana.—Adams, Allen, Benton, Boone, Clay, Clinton, Decatur, Delaware, Elkhart, Gibson, Grant, Greene, Hamilton, Hendricks, Jasper, Kosciusko, Lake, Lawrence, Madison, Marion, Marshall, Monroe, Montgomery, Newton, Porter, Posey, Scott, Spencer,[1] Starke, Steuben, Switzerland, Tippecanoe, Tipton, Warren, Warrick,[1] Wayne, Wells, White.

Iowa.—Adair, Appanoose, Benton, Black Hawk, Boone, Bremer, Buena Vista, Cedar, Cerro Gordo, Clarke, Clay, Clinton, Dallas, Delaware, Des Moines, Dickinson, Dubuque, Emmet, Fayette, Floyd, Greene, Grundy, Hamilton, Hardin, Harrison, Henry, Jackson,[1] Jasper, Jefferson, Johnson, Jones,[1] Lee, Linn, Louisa, Madison, Mahaska, Marshall, Mills, Mitchell, Montgomery, Muscatine, O'Brien, Page, Palo Alto, Plymouth, Polk, Pottawattamie, Ringgold, Scott, Sioux, Story, Tama, Van Buren, Wapello, Wayne, Webster, Winnebago, Winneshiek, Woodbury, Worth, Wright.

Kansas.—Allen, Atchison,[1] Brown, Butler,[1] Cherokee, Cowley, Crawford,[1] Finney,[1] Gray,[1] Greenwood, Jewell, Labette,[1] Leavenworth, Montgomery, Reno, Riley, Russell,[1] Sedgwick,[1] Shawnee.

Kentucky.—Christian, Garrard, Jessamine, Logan, McCracken, Madison, Mason, Muhlenberg, Rockcastle, Scott, Shelby, Union, Warren.

Louisiana.—Acadia, Bienville, Caddo, Calcasieu,[1] Concordia, De Soto, East Baton Rouge, East Carroll, East Feliciana, Iberia, Jefferson,[1] Lafayette, La Salle, Lincoln, Natchitoches, Orleans,[1] Ouachita, Plaquemines,[1] Rapides, Sabine, St. Charles,[1] St. John the Baptist,[1] St. Martin, Tangipahoa, Washington, Webster, West Carroll, Winn.

Maine.—Aroostook,[1] Cumberland, Penobscot.[1]

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[1] Part of county.

Maryland.—Allegany, Anne Arundel, Baltimore, Calvert, Caroline, Carroll, Cecil, Charles, Dorchester, Frederick, Garrett, Harford, Howard, Kent, Montgomery, Prince Georges, Queen Annes, St. Marys, Somerset, Talbot, Washington, Wicomico, Worcester.

Massachusetts.—Barnstable, Berkshire, Bristol, Franklin,[1] Hampden,[1] Hampshire,[1] Norfolk, Plymouth, Worcester.

Michigan.—Alger,[1] Allegan, Antrim, Bay,[1] Berrien, Calhoun, Cass, Emmet, Genesee, Gratiot, Huron,[1] Ingham, Isabella, Kalamazoo, Livingston, Macomb, Manistee, Monroe,[1] Oakland,[1] Ogemaw, Ottawa, Presque Isle, Saginaw,[1] St. Joseph, Shiawassee,[1] Tuscola,[1] Van Buren, Wexford.

Minnesota.—Aitkin,[1] Anoka, Beltrami, Blue Earth, Carlton,[1] Cook,[1] Goodhue, Itasca,[1] Jackson, Koochiching,[1] Lac qui Parle, Lyon,[1] Olmsted, Pennington, Polk,[1] Ramsey, Rice, St. Louis,[1] Stevens, Wadena.

Mississippi.—Adams, Alcorn, Amite, Chickasaw, Choctaw, Clarke, Clay, Coahoma, Copiah,[1] Covington, Forrest, George, Grenada, Hancock,[1] Harrison, Hinds, Holmes, Issaquena,[1] Jackson, Jasper, Jefferson Davis, Jones, Lafayette, Lamar, Lauderdale, Lee, Lincoln, Lowndes, Madison, Marshall, Monroe, Montgomery, Newton, Noxubee, Oktibbeha, Pearl River, Perry, Pike, Pontotoc, Prentiss, Rankin, Sharkey,[1] Simpson, Smith, Warren, Wayne, Wilkinson, Winston, Yazoo.[1]

Missouri.—Andrew, Atchison, Barry, Barton, Bates, Boone, Buchanan, Caldwell, Callaway, Cape Girardeau, Carroll, Cass, Cedar, Chariton, Cole, Cooper, Crawford, De Kalb, Dunklin, Franklin, Greene, Grundy, Harrison, Howell, Jackson, Johnson, Knox, Laclede, Lafayette, Lawrence, Lincoln, Macon, Marion, Miller, Mississippi, Newton, Nodaway, Pemiscot, Perry, Pettis, Phelps, Pike, Platte, Polk, Putnam, Ralls, Ray, Reynolds, Ripley, St. Charles,[1] St. Francois, St. Louis, Saline, Scotland, Shelby, Stoddard, Texas, Warren,[1] Webster.

Montana.—Gallatin,[1] Missoula,[1] Ravalli,[1] Stillwater,[1] Yellowstone.[1]

Nebraska.—Adams, Antelope, Banner, Boone, Box Butte, Buffalo, Burt, Butler, Cass, Chase, Cheyenne, Colfax, Cuming, Dakota, Dawes, Dawson, Deuel, Dodge, Douglas, Fillmore, Gage, Garden, Gosper,[1] Hall, Hamilton,[1] Howard, Jefferson, Johnson, Kearney, Kimball, Lancaster, Lincoln,[1] Madison, Merrick, Morrill, Nance, Nemaha, Otoe, Pawnee, Perkins, Phelps, Pierce,[1] Platte, Polk, Redwillow, Richardson, Sarpy, Saunders, Scotts Bluff, Seward, Sheridan, Sioux, Stanton,[1] Thurston, Washington, Wayne,[1] Webster.

Nevada.—Churchill,[1] Clark,[1] Lyon.[1]

New Hampshire.—Hillsborough,[1] Merrimack.

New Jersey.—Atlantic, Bergen,[1] Burlington,[1] Camden, Cape May, Cumberland,[1] Essex,[1] Gloucester, Hudson,[1] Hunterdon, Mercer, Middlesex,[1] Monmouth, Morris,[1] Ocean,[1] Passaic,[1] Salem, Somerset, Sussex, Union,[1] Warren.

New Mexico.—Bernalillo,[1] Chaves,[1] Dona Ana,[1] Eddy,[1] Sandoval,[1] Socorro,[1] Valencia.[1]

New York.—Broome,[1] Cayuga, Chautauqua, Chemung,[1] Chenango, Clinton, Columbia, Cortland, Dutchess, Essex,[1] Genesee, Herkimer, Jefferson, Kings,[1] Livingston, Madison, Monroe, Montgomery, Nassau,[1] Niagara, Oneida, Onondaga,[1] Ontario, Orange, Orleans, Oswego, Putnam, Queens,[1] Rockland, St. Lawrence, Saratoga, Schoharie, Seneca,[1] Steuben,[1] Suffolk,[1] Tompkins, Washington, Wayne, Westchester, Yates.

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[1] Part of county.

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North Carolina.—Alamance, Alexander,[1] Alleghany, Anson, Ashe, Beaufort, Bertie, Bladen, Buncombe, Burke,[1] Cabarrus, Caldwell, Camden, Caswell, Catawba,[1] Cherokee, Chowan, Cleveland, Columbus, Craven, Cumberland, Currituck, Davidson, Davie,[1] Duplin, Durham, Edgecombe, Forsyth, Gaston, Granville, Greene, Guilford, Halifax, Harnett, Haywood, Henderson, Hertford, Hoke, Hyde,[1] Iredell.[1]

North Dakota.—Adams,[1] Barnes, Bottineau, Cass, Dickey, Foster,[1] Grand Forks,[1] Griggs,[1] Hettinger,[1] La Moure, McHenry, McKenzie,[1] Morton,[1] Ransom, Richland, Sargent, Stutsman,[1] Towner,[1] Traill, Williams.[1]

Ohio.—Ashtabula,[1] Auglaize, Clermont, Coshocton, Cuyahoga,[1] Delaware,[1] Fairfield,[1] Franklin,[1] Fulton, Geauga, Hamilton, Licking,[1] Lorain,[1] Lucas, Madison, Mahoning, Marion, Medina,[1] Meigs, Miami, Montgomery, Ottawa,[1] Paulding, Pickaway, Portage, Sandusky, Stark, Summit,[1] Trumbull, Union,[1] Wayne, Wood.[1]

Oklahoma.—Bryan, Canadian, Johnston,[1] Kay, Marshall,[1] Muskogee, Oklahoma, Payne, Roger Mills.

Oregon.—Baker,[1] Benton, Clackamas, Coos,[1] Curry,[1] Jackson,[1] Josephine, Klamath,[1] Lane, Linn, Marion,[1] Multnomah, Polk, Union,[1] Washington, Yamhill.

Pennsylvania.—Adams, Bedford, Berks, Blair, Bradford, Bucks,[1] Cambria,[1] Center, Chester, Clearfield, Clinton,[1] Dauphin,[1] Erie, Greene, Lancaster, Lebanon,[1] Lehigh, Lycoming, Mercer, Montgomery, Washington, York.

Porto Rico.—Arecibo to Ponce (narrow strip across island surveyed).

Rhode Island.—Bristol, Kent, Newport, Providence, Washington.

South Carolina.—Abbeville,[1] Anderson, Bamberg, Barnwell, Berkeley, Calhoun,[1] Charleston,[1] Cherokee, Chester, Chesterfield, Clarendon, Colleton,[1] Darlington, Dorchester, Fairfield, Florence, Georgetown, Greenville, Greenwood, Hampton, Horry, Kershaw, Lancaster, Laurens,[1] Lee, Lexington, Marlboro, Newberry, Oconee, Orangeburg, Richland, Saluda, Spartanburg, Sumter, Union, York.

South Dakota.—Beadle, Brookings,[1] Butte,[1] Douglas. Grant, Jones,[1] Lyman,[1] McCook, Meade,[1] Stanley,[1] Union, Walworth.

Tennessee.—Bedford, Bledsoe,[1] Cocke,[1] Coffee, Cumberland,[1] Davidson, Dickson, Giles, Grainger, Greene,[1] Hardin, Hawkins,[1] Henderson, Henry, Jackson, Knox, Lawrence, Lewis, Madison, Maury, Meigs, Montgomery, Overton, Putnam, Rhea,[1] Robertson, Shelby, Sullivan,[1] Sumner, Van Buren.[1]

Texas.—Anderson, Angelina,[1] Archer, Bastrop, Bell, Bexar,[1] Bosque,[1] Bowie, Brazoria,[1] Brazos, Caldwell,[1] Cameron, Camp, Cherokee,[1] Coleman, Dallas, Delta, Denton, Dickens, Eastland, Ellis, El Paso,[1] Erath, Franklin, Freestone, Grayson, Guadalupe,[1] Harris, Harrison, Hays,[1] Henderson, Hidalgo, Houston, Jefferson, Lamar,[1] Lavaca, Lee, Lubbock, McLennan,[1] Milam, Montgomery,[1] Morris, Nacogdoches, Nueces,[1] Red River, Reeves, Robertson, Rockwall, Rusk,[1] San Saba, Smith, Tarrant, Taylor, Titus, Travis,[1] Tyler,[1] Washington, Webb,[1] Wichita, Wilbarger,[1] Williamson,[1] Wilson.

Utah.—Box Elder,[1] Cache,[1] Davis,[1] Duchesne,[1] Millard,[1] Salt Lake,[1] Sanpete,[1] Sevier,[1] Uintah,[1] Utah.[1]

Vermont.—Addison,[1] Windsor.

Virginia.—Accomac, Albemarle,[1] Alexandria (now Arlington), Amelia,[1] Appomattox, Augusta,[1] Bedford,[1] Botetourt,[1] Buckingham,[1] Campbell, Charlotte,[1] Chesterfield, Elizabeth City, Fairfax, Franklin,[1] Frederick, Gloucester, Greene,[1] Hanover, Henrico, James City, Loudoun,[1]

[1] Part of county.

Louisa, Lunenburg,[1] Montgomery, Nansemond,[1] Nelson,[1] Norfolk,[1] Northampton, Nottoway,[1] Page,[1] Pittsylvania, Princess Anne,[1] Prince Edward,[1] Roanoke,[1] Rockingham,[1] Warwick, York.

Washington.—Benton, Chelan,[1] Franklin, Grant,[1] Island, Klickitat,[1] Skamania,[1] Snohomish,[1] Spokane, Stevens, Walla Walla,[1] Whatcom,[1] Yakima.[1]

West Virginia.—Barbour, Berkeley, Boone, Braxton, Brooke, Cabell, Calhoun, Clay, Doddridge, Fayette, Gilmer, Grant, Hancock, Harrison, Jackson, Jefferson, Kanawha, Lewis, Lincoln, Logan, McDowell, Marion, Marshall, Mason, Mercer, Mineral, Mingo, Monongalia, Morgan, Nicholas, Ohio, Pleasants, Preston, Putnam, Raleigh, Ritchie, Roane, Summers, Taylor, Tucker, Tyler, Upshur, Wayne, Webster, Wetzel, Wirt, Wood, Wyoming.

Wisconsin.—Adams, Ashland,[1] Bayfield,[1] Buffalo, Columbia, Dane, Door, Douglas,[1] Fond du Lac, Green, Green Lake, Iowa, Jackson, Jefferson, Juneau, Kenosha, Kewaunee, La Crosse, Milwaukee, Monroe, Outagamie, Ozaukee, Pierce, Portage, Racine, Rock, Vernon, Walworth, Washington, Waukesha, Waupaca, Waushara, Wood.

Wyoming.—Albany,[1] Goshen.[1]

Reconnaissance Soil Surveys

The following list gives the areas that have been covered by reconnaissance soil surveys. These surveys generally cover much larger areas than the detailed surveys and are mapped on a smaller scale, usually on a scale of 1 inch equals 3 miles or 1 inch equals 4 miles. Only the dominant soil types are mapped, and the soils of small extent, which can not be shown separately on the map, are included with the more extensive soils. A number of counties included in reconnaissance surveys are also covered by detailed surveys:

Alaska.—Cook Inlet-Susitna region, Yukon-Tanana region, Copper River region (the soils, agriculture, and other resources of the Kenai Peninsula region of Alaska).

Arkansas.—The Ozark region in Arkansas and Missouri (Baxter, Benton, Boone, Carroll, Cleburne, Conway, Crawford, Faulkner, Fulton, Izard, Johnson, Madison, Marion, Newton, Pope, Searcy, Sharp, Stone, Van Buren, and Washington Counties, and parts of Franklin, Independence, Lawrence, Lonoke, Pulaski, Randolph, and White Counties, Ark.; and Barry, Benton, Camden, Carter, Christian, Cole, Crawford, Dade, Dallas, Dent, Douglas, Franklin, Gasconade, Greene, Hickory, Howell, Iron, Jefferson, Laclede, Lawrence, McDonald, Madison, Maries, Miller, Moniteau, Morgan, Newton, Oregon, Osage, Ozark, Perry, Phelps, Polk, Pulaski, Reynolds, Ste. Genevieve, St. Francois, Shannon, Stone, Taney, Texas, Washington, Wayne, Webster, and Wright Counties, and parts of Barton, Bollinger, Butler, Cape Girardeau, Cedar, Cooper, Jasper, Pettis, Ripley, St. Clair, and St. Louis Counties, Mo.).

California.—Central southern (parts of Los Angeles, Orange, Riverside, San Bernardino, and San Diego Counties).

Lower San Joaquin Valley area (parts of Alameda, Calaveras, Contra Costa, Fresno, Madera, Merced, San Joaquin, Stanislaus, and Tuolumne Counties).

Middle San Joaquin Valley area (parts of Fresno, Kings, and Tulare Counties).

Sacramento Valley area (parts of Amador, Butte, Colusa, Contra Costa, Glenn, Placer, Sacramento, San

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[1] Part of county.

Joaquin, Solano, Sutter, Tehama, Yolo, and Yuba Counties).

San Diego area (parts of Orange, Riverside, and San Diego Counties).

San Francisco Bay area (San Francisco and San Mateo Counties, and parts of Alameda, Contra Costa, Marin, Napa, San Joaquin, Santa Clara, Santa Cruz, Solano, and Sonoma Counties).

Upper San Joaquin Valley area (parts of Fresno, Kern, Kings, San Luis Obispo, Santa Barbara, and Tulare Counties).

Georgia.—Tattnall County.

Kansas.—Western (Barber, Barton, Cheyenne, Clark, Comanche, Decatur, Edwards, Ellis, Finney, Ford, Gove, Graham, Grant, Gray, Greeley, Hamilton, Haskell, Hodgeman, Kearny, Kiowa, Lane, Logan, Meade, Morton, Ness, Norton, Osborne, Pawnee, Phillips, Pratt, Rawlins, Rooks, Rush, Russell, Scott, Seward, Sheridan, Sherman, Smith, Stafford, Stanton, Stevens, Thomas, Trego, Wallace, and Wichita Counties).

Michigan.—Ontonagon County.

Minnesota.—Lake of the Woods County.

Missouri.—The Ozark region. (See Arkansas.)

Montana.—Entire State.

Northeastern (Carter, Custer, Dawson, Fallon, Prairie, Richland, Rosebud, Sheridan, Valley, and Wibaux Counties).

Nebraska.—Western (Adams, Banner, Blaine, Box Butte, Boyd, Brown, Buffalo, Chase, Cherry, Cheyenne, Custer, Dawes, Dawson, Deuel, Dundy, Frontier, Franklin, Furnas, Garden, Garfield, Gosper, Grant, Greeley, Hall, Harlan, Hayes, Hitchcock, Holt, Hooker, Howard, Kearney, Keith, Keyapaha, Kimball, Lincoln, Logan, Loup, McPherson, Morrill, Perkins, Phelps, Redwillow, Rock, Scotts Bluff, Sheridan, Sherman, Sioux, Thomas, Valley, Webster, and Wheeler Counties).

North Dakota.—Western (Adams, Billings, Bottineau, Bowman, Burke, Burleigh, Divide, Dunn, Emmons, Golden Valley, Hettinger, McHenry, McKenzie, McLean, Mercer, Morton, Mountrail, Oliver, Renville, Sheridan, Stark, Ward, and Williams Counties).

Ohio.—Entire State.

Pennsylvania.—Northeastern (Bradford, Clinton, Lackawanna, Lycoming, Pike, Sullivan, Susquehanna, Tioga, Wayne, and Wyoming Counties).

Northwestern (Cameron, Crawford, Elk, Erie, Forest, Lawrence, McKean, Mercer, Potter, Venango, and Warren Counties).

South central (Adams, Bedford, Blair, Cambria, Center, Clearfield, Cumberland, Franklin, Fulton, Huntingdon, Juniata, Mifflin, Perry, Snyder, Somerset, and Union Counties).

Southeastern (Berks, Bucks, Carbon, Chester, Columbia, Dauphin, Delaware, Lancaster, Lebanon, Lehigh, Luzerne, Monroe, Montgomery, Montour, Northampton, Northumberland, Philadelphia, Schuylkill, and York Counties).

Southwestern (Allegheny, Armstrong, Beaver, Butler, Clarion, Fayette, Greene, Indiana, Jefferson, Washington, and Westmoreland Counties).

South Dakota.—Western (Armstrong, Bennett, Butte, Corson, Custer, Dewey, Fall River, Gregory, Harding, Lawrence, Lyman, Meade, Mellette, Pennington, Perkins, Shannon, Stanley, Todd, Tripp, Washabaugh, Washington, and Ziebach Counties).

Texas.—Central Gulf coast (Aransas, Bee, Brazoria, Calhoun, De Witt, Goliad, Jackson, Karnes, Matagorda, Refugio, Victoria, and Wharton Counties).

Northwest (Bailey, Cochran, Cottle, Crosby, Dickens, Floyd, Foard, Garza, Hale, Hardeman, Haskell, Hockley, Kent, King, Knox, Lamb, Lubbock, Lynn, Motley, Stonewall, Terry, and Yoakum Counties).

Panhandle (Armstrong, Briscoe, Carson, Castro, Childress, Collingsworth, Dallas, Deaf Smith, Donley, Gray, Hall, Hansford, Hartley, Hemphill, Hutchinson, Lipscomb, Moore, Ochiltree, Oldham, Parmer, Potter, Randall, Roberts, Sherman, Swisher, and Wheeler Counties).

South (Cameron, Duval, Hidalgo, Nueces, San Patricio, Starr, Webb, and Zapata Counties).

South central (Bandera, Blanco, Burnet, Comal, Crockett, Edwards, Gillespie, Kendall, Kerr, Kimble, Llano, Mason, Menard, Schleicher, Sutton, and Val Verde Counties and parts of Hays, Real, and Travis Counties).

Southwest (Atascosa, Bexar, Dimmit, Frio, Kinney, La Salle, Live Oak, McMullen, Maverick, Medina, Uvalde, Wilson, and Zavalla Counties).

West central (Andrews, Borden, Coke, Concho, Crane, Dawson, Ector, Fisher, Gaines, Glasscock, Howard, Irion, Jones, Loving, Martin, Midland, Mitchell, Nolan, Reagan, Runnels, Scurry, Sterling, Taylor, Tom Green, Upton, Ward, and Winkler Counties).

Washington.—Columbia River basin area.

Puget Sound basin, eastern part of Washington (parts of King, Pierce, Skagit, Snohomish, and Whatcom Counties).

Puget Sound basin, western part of Washington (Island, Kitsap, San Juan, and Thurston Counties, and parts of Grays Harbor, Clallam, Jefferson, Lewis, Mason, and Pierce Counties.

Southwestern (Clarke, Cowlitz, Pacific, and Wahkiakum Counties, and parts of Lewis and Skamania Counties).

Wisconsin.—Marinette County.

Northeastern (Florence, Forest, Langlade, Marinette, Oconto, and Shawano Counties).

North part north central (Iron, Oneida, Price, and Vilas Counties, and parts of Ashland and Rusk Counties).

South part north central (Clark, Lincoln, Marathon, and Taylor Counties).

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[illegible] west (Andrews, Borden, Cochran, Cottle, Crosby, [illegible] Floyd, Garza, [illegible], Hale, Hardeman, Haskell, [illegible] King, Knox, [illegible], Lubbock, Lynn, Motley, Stonewall, Terry, and Yoakum Counties).

Panhandle (Armstrong, Briscoe, Carson, Castro, Childress, [illegible] Hall, Hansford, Hartley, H[illegible], Hutchinson, Lipscomb, Moore, Ochiltree, Oldham, Parmer, Potter, Randall, Roberts, Sherman, Swisher, and Wheeler Counties).

South (Cameron, Duval, Hidalgo, Nueces, San Patricio, Starr, Webb, and Zapata Counties).

South central (Bandera, Blanco, Burnet, Comal, Crockett, Edwards, Gillespie, Kendall, Kerr, Kimble, Llano, Mason, Menard, Schleicher, Sutton, and Val Verde Counties and parts of Hays, Real, and Travis Counties).

Southwest (Atascosa, Bexar, Dimmit, Frio, Kinney, La Salle, Live Oak, McMullen, Maverick, Medina, Uvalde, [illegible], and Zavala Counties).

West [illegible] (Andrews, Borden, Coke, Concho, Crane, Dawson, Ector, Fisher, [illegible]nes, Glasscock, Howard, Irion, [illegible] Irving, Martin, Midland, Mitchell, Nolan, [illegible] and Winkler Counties).

Washington.—Columbia River basin area.

Puget Sound basin, eastern part of Washington (parts of King, Pierce, Skagit, Snohomish, and Whatcom Counties).

Puget Sound basin, western part of Washington (Island, [illegible] Mason, and Thurston Counties and parts of [illegible] Pierce).

Southwestern (Clarke, Cowlitz, [illegible], and Wahkiakum Counties, and parts of Lewis and Skamania [illegible]).

Wisconsin.—[illegible]

[illegible] (Florence, Forest, Langlade, [illegible] Oconto, and Shawano Counties).

[illegible] north central (Iron, Oneida, Price, and Vilas Counties and parts of Ashland and Rusk Counties).

South part north central (Clark, Lincoln, [illegible], and Taylor Counties).

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Mrs. Sullivan

Soils Affecting Grazing. (See 11.91)

Soil Characteristics.—Properties of the soils influence the character and abundance of native range vegetation. Regions that have similar climatic and topographic conditions show variations in the predominant native plants and grasses that can be attributed only to differences in the soils. Sandy soils will not support the same plant groups as heavy clays. Striking differences may be seen between the plants of the acid and of the alkaline soils. The quantity of forage produced in a given space of time, upon which depends the carrying capacity of a pasture, varies with the quantity of the available soil moisture. The power of a soil to absorb and retain the water that it receives from precipitation, whether much or little, is determined by the thickness, texture, structure, alkali content, chemical composition, and other characteristics of both soil and subsoil. A study of the soil profile to a depth of 3 feet will show whether the range is producing the kind and quantity of grass of which it is capable.

The character of the soil must be taken into account in the selection of land for growing supplemental feed within the grazing districts. The soil plays an equally important part in the problems that arise in the management of grazing land. Texture and profile characteristics of the soil must be considered in any attempt to prevent washing and blowing. The tendency of a soil to puddle if trampled upon when wet is proportional to the quantity of fine clay present. The possibility of restoring or improving a grass covering is determined largely by the nature of the soil. A soil of favorable composition upon which the grass has been destroyed by overgrazing will rapidly become grassed over if protected. Other areas can not be restored on account of some unfavorable soil condition; for example, large sections in the semiarid belt have bare or "slick" spots which can not be improved since the absence of grass is due to an alkali hardpan. It is not practicable on low-priced grazing land to attempt to improve the physical or chemical composition of the soil. The rancher can, however, study his soil and adapt his operations to the conditions that prevail.

Western Soil Types (Relation to Vegetation).—The Western States possess soils that have a range of characteristics almost as wide as may be found in the entire country:

(1) Soils with a small to medium percentage of organic matter, large percentage of lime, and medium to large percentage of other important mineral constituents. Found in the Great Plains east of the Rocky Mountains, in central New Mexico, and in small areas throughout the mountain regions. Usually characterized by a cover of short or desert grasses.

(2) Soils with a small percentage of organic matter, large percentage of lime carbonate, and medium to large percentage of other important mineral constituents. Known as the desert soils of Arizona, California, Idaho, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. Not grassland soils in a true sense, or grazing lands, but more strictly browsing lands. Characterized by desert shrubs, such as sagebrush and shad scale.

(3) Soils with a medium content of organic matter, small percentage of lime carbonate, and a medium percentage of other important mineral constituents. Found in the mountain meadows and treeless mountain areas. Characterized by alpine meadows.

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Great Plains Soil Types.—Two kinds of soil universally recognized are hard land and sandy land. A local expression in the Southwest for hard land is "tight" soil. Hard land may be described as dark-brown hard land and brown hard land.

Dark-brown hard land.—Occurs along the eastern part of the grazing region, and the farther east any part of it extends the darker its color. It is darkest in Montana and in the Dakotas, being darkest of all in South Dakota It is dark brown in southeastern Wyoming and western Nebraska, in western Kansas, and in a rather narrow strip in western Texas. Strips of the dark-colored soil, usually narrow, also occur on the Great Plains immediately east of the foot of the mountains and around each of the isolated mountain groups. Examples are found around the Black Hills, the Little Rocky Mountains, and the Bear Paw Mountains. A larger example of the same type is that in the Judith Basin in Montana. The vegetation on such soils consists for the most part of short grasses, and many plants more characteristic of the mountain areas, such as yarrow, goldenrod, and roses. The dark-brown hard land is more productive than the brown hard land. This is true of the native crop of grasses, as well as of any cultivated crop. The short-grass sod on the soils of this group constitutes a more continuous cover.

Brown hard land.—Lies in a belt of irregular width, almost discontinuous in places, east of the mountain-foot belt of dark-colored hard land and west of the main body of the latter. A large area lies in northern Montana extending along the international boundary from Turner to a short distance west of Sweetgrass. It narrows southward and passes into Wyoming near Sheridan, where it is a mere strip a few miles wide. The belt then widens rapidly southward and includes the larger part of eastern Wyoming, except the southeastern corner. It includes most of the Great Plains part of Colorado, and the most of eastern New Mexico, south of Tucumcari. This region carries typical short-grass vegetation and is excellent grazing land.

The soils of both groups consist of a layer of loose deflocculated silty or sandy material on the immediate surface, ranging from a mere film in thickness up to 3 inches. Usually it is about 2 inches thick, and is underlain by a firm or somewhat compact horizon 6 inches thick in the dark-brown hard land and a little less than that in the brown hard land. The soil below the second or compact horizon in the brown land is looser than the corresponding soil in the dark-brown hard land.

Sandy land.—Characteristics are well known. For winter grazing sandy lands are somewhat better than the hard lands, but overgrazing on them is more disastrous. They have a lower percentage of organic matter, lime, and other mineral constituents than the soils of the hard land in a corresponding belt. The firm horizon usually is not present.

Relation of Vegetative Cover to Erosion of Soil.—Character and abundance of the vegetation exert a great influence on the erosion of soil on watershed areas and in turn are conditioned by the extent of erosion which may already have taken place, especially in regions where heavy showers occur over comparatively short periods. A satisfactory cover of herbaceous vegetation on the slopes of watersheds serves to check run-off and to equalize the flow from rainstorms, thereby reducing the violence of floods and preventing sheet erosion, which depletes the soil, and the formation of gullies on the slopes of the watersheds. Both these forms of erosion are highly de-

structive. The soil material transported from the higher to the lower elevations will be deposited in water-storage reservoirs, thereby reducing their capacity, will cause the pollution of streams, and will damage agriculture or grazing lands wherever excessive material is deposited. Moreover, the removal of the more valuable surface soil in the drainage areas will reduce the forage-producing capacity of the lands where the erosion takes place.

Grazing should be regulated in a manner which will not interfere with the protective value of the plant cover. Usually well-regulated grazing will prevent this interference. However, on watersheds where the vegetation has already been badly depleted or on areas of exceptionally high value for watershed purposes it may be necessary to restrict grazing or to exclude it entirely, until an adequate plant cover has been restored.

SOIL TECHNOLOGY

Soil Fertility

General.—Soil fertility may be defined as soil productivity, or the ability of a soil to produce good crop yields.

Soil fertility is determined by such factors as water or soil moisture, soil aeration, tilth, availability of nutrient elements, and soil sanitation or freedom from injurious agents within the soil.

Plant-Food Elements.—Carbon and oxygen are obtained from the carbon dioxide of the air, and oxygen and hydrogen from water. Nitrogen, except under certain conditions, phosphorus, potassium, calcium, magnesium, sulphur, and iron must be obtained by the plant from the soil solution. Chlorine, silicon, and sodium occur in plants and are necessary for their growth.

Nitrogen may be added to a soil in the form of farm manure, nitrogenous fertilizers, and green-manure crops, like clover and soy beans. Phosphorus may be added by applying phosphate fertilizers or farm manure. Potassium may be added to a soil in the form of farm manure, crop residues, and potash fertilizers.

The approximate quantity of nitrogen, phosphorus, and potassium taken from soils by different crops, on the acre basis, is shown in the following table:

Approximate quantity of plant-food elements in one crop

Crop	Yield per acre	Nitrogen	Phosphorus	Potassium
		Pounds	*Pounds*	*Pounds*
Alfalfa	20,000 pounds	120.0	13.0	83.0
Clover:				
Crimson	16,000 pounds	72.0	8.0	52.0
Red	12,000 pounds	66.0	7.0	50.0
White	8,000 pounds	40.0	7.0	20.0
Cowpea	12,000 pounds	54.0	6.0	45.0
Velvet bean	20,000 pounds	110.0	13.0	91.0
Vetch	10,000 pounds	50.0	4.4	37.0
Corn:				
Grain	25 bushels	23.2	4.0	4.6
Stalks	1,500 pounds	15.0	2.0	17.4
Green forage	20,000 pounds	60.0	11.4	22.9
Wheat:				
Grain	25 bushels	30.0	5.0	5.0
Straw	2,500 pounds	12.5	1.7	12.5
Rye:				
Grain	20 bushels	19.1	4.3	5.6
Straw	2,000 pounds	10.0	2.6	14.1
Green forage	15,000 pounds	67.5	13.2	81.0
Oats:				
Grain	25 bushels	16.0	2.9	4.0
Straw	1,250 pounds	8.0	1.1	13.0
Barley:				
Grain	25 bushels	21.0	4.0	5.0
Straw	16,000 pounds	9.6	1.4	14.6
Potatoes	150 bushels	31.5	6.0	37.0
Sweet potatoes	200 bushels	27.5	4.8	45.7
Beets	25,000 pounds	62.5	11.0	104.0
Turnips	20,000 pounds	50.0	8.8	74.7

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Nitrogen.—Nitrogen is a necessary constituent for life and growth of the protoplasm of plant cells. Most plants obtain their nitrogen from the soil solution, largely in the form of nitrates. An abundant supply of nitrates stimulates the formation of new growth, leaves and stems, and consequently postpones or retards the normal maturing of the plant, the flowering and setting of seeds. An insufficient supply of nitrates is shown by stunted growth and lack of the green color which is an indication of vegetative activity.

Ammonification: The formation of ammonia by the decomposition of nitrogenous protein material that finds its way into soils in the remains of animal or vegetable life, or is added in organic fertilizers, is known as ammonification. Ammonifying bacteria, which are usually abundant in air, rain water, surface soil, and stable manure, cause the formation of ammonium compounds. Although conditions for their growth are usually favorable in ordinary soils, their activity and the formation of ammonia are determined chiefly by the character of the nitrogenous material present or supplied to them in fertilizer. Nitrogen required by plants should usually be furnished in the form of nitrates. It is further necessary for the formation of nitrates from organic nitrogen compounds that they first be ammonified. The nature of the material is more important than the soil conditions.

Nitrification: This consists of the formation of nitrous acid or nitrites from the ammonia or ammonium compounds and the subsequent change to nitric acid or nitrates, which is essentially oxidation. This change is caused by nitrifying bacteria, which are widely distributed in soils. The nitrous and nitric acids unite with a base of the soil.

Nitrification is generally present in arable soils, but is greatly influenced by soil conditions, much more so than is the process of ammonification. The most important conditions are as follows:

(1) Access of air. This is brought about or maintained by cultivation and drainage.

(2) Proper temperatures. It is most active between 54° and 99° F., and practically ceases below 37° or above 120° F.

(3) Sufficient moisture. The process of nitrification is practically at a standstill in air-dried soil.

(4) Presence of a base to combine with the free nitric acid formed. The nitrifying organisms are sensitive to acidity, and unless some base is present to neutralize the nitric acid formed by their growth their activity will diminish. In the average soil under normal conditions potassium, sodium, calcium, or magnesium resulting from the decomposition of soil minerals are sufficient for this purpose. When additional basic material is needed to assist nitrification calcium in the form of carbonate or oxide is suitable.

Nitrates produce growth. An abundant supply stimulates the further production of leaves and stems and retards the normal maturing of the plant, when vegetative growth ceases and the plant flowers and sets seed. It is thus possible by supplying nitrates or improving the conditions for their formation to delay the maturing of a crop, or, vice versa, by withholding nitrates at this stage to hasten maturity.

Denitrification: This is a process of reduction or deoxidation by which nitrates are broken down and free nitrogen is given off. This is caused by microorganisms known as denitrifying bacteria.

The condition favorable for the process of denitrification is chiefly the absence of air and proper temperature and moisture for the growth of such microorganisms.

This condition exists in water-logged or poorly drained soils, and is within the power of the farmer to remedy. Any large quantity of nitrites in a soil solution is in itself injurious to crops, but such an accumulation seldom occurs, for they are usually reduced to free nitrogen as fast as formed. Manure contains large numbers of denitrifying bacteria, and extremely heavy applications of straw and coarse manure may result in some loss through the action of these organisms.

Nitrogen fixation: The nitrogen content of a soil could be maintained or increased only by the addition of fertilizers or manures, were it not for the fact that there are at least two agencies through which the nitrogen of the air is fixed in the soil.

(1) Certain bacteria have been found to grow in very intimate relation on the roots of leguminous plants. Such growth produces enlargements or nodules on the roots which are high in nitrogen. This large nitrogen content comes from the nitrogen of the air. The nitrogen fixed in these nodules from the air may be transported to other parts of the plant and used in the same way as though obtained in the regular manner from the soil solution. If such a crop is plowed under as green manure the nitrogen fixed in the nodules becomes part of the store of nitrogen in the soil. There are specific nitrogen-fixing bacteria for different legumes, and this fact has led to the practice of inoculating the seed or soil either with cultures of the bacteria or with soils on which the legume has been successfully grown with nodule formation.

(2) Another form of nitrogen fixation is caused by several species of bacteria which grow in the soil but are not associated with roots of growing crops. The most common form is known as azotobacter, and is widely distributed in soils. However, its use by inoculation has not advanced to the stage reached in the use of the nodule-forming bacteria.

A plentiful supply of available carbohydrates is necessary for vigorous growth with both these forms, and neither one is active in fixing atmospheric nitrogen when there is much available nitrogen in the soil.

Phosphorus.—Phosphorus is an essential element of the protoplasm of living cells. Unless a plant is supplied with phosphorus in a soluble form there can be no life or growth. It tends to hasten maturity, flowering, and the setting of seed. In the early life of the plant it promotes root development, and throughout the growth it tends to increase the ratio of seed or grain to straw or vegetation.

Phosphorus is found in soils either as mineral phosphates or as organic phosphorus compounds derived from the remains of plants or animals. The organic phosphorus compounds on decomposition yield phosphoric acid, and this combines with the bases in the soil to form mineral phosphates. Crop plants usually obtain their phosphorus from solution of the slightly soluble soil minerals.

Potassium.—Potassium is found most abundantly in the young and growing parts of plants. It forms carbohydrates—starch and sugar—and aids in its transfer from one part of the plant where it may have been stored to another where it is needed for new growth. It is also intimately associated with the proper development of stem and leaves. Plants deprived of sufficient potassium show poorly developed leaves or weak and brittle stems. This is so pronounced in some plants, such as the potato, that the term "potash hunger" has been used to designate this need for potassium by the plant.

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Potassium also holds some relation to the development and functioning of acids in plant life, since acid plant juices contain acid potassium salts. Where supplied to growing plants in abundance it has an effect in prolonging the period of growth of vegetation and delaying the maturing of crops.

The potash requirements of vigorously growing crops are best met when the slightly soluble soil potash is supplemented by an easily soluble form supplied in fertilizers.

Calcium.—Calcium strengthens and builds up the cell walls of the growing plant, and is also associated with potassium in the transfer of starch from one part of the plant to another. Frequently it is associated in the plant with acids, both organic and inorganic, and plays a part in the functions of the plant in neutralizing acids formed. It is found in the parts of plants that have attained their growth, such as mature green leaves.

Calcium is a constituent of many soil minerals when, with other bases, it is in combination with silica. It may also be present in soils as carbonate, sulphate, or in combination with some of the constituents of humus. The sulphate and carbonate are appreciably soluble in soil water, but the silicates and humus combinations are but slightly soluble, and where the latter are the only forms in the soil the crops grown on it may not be supplied with calcium enough for maximum growth. The supplying of this necessary calcium would be one of the benefits of liming.

The distribution of the plant-food elements—nitrogen, phosphorus, potassium, and calcium—in different parts of some crop plants is shown in the following table:

Pounds of plant-food elements in 1,000 pounds of dry matter

Plants	Nitrogen	Phosphorus	Potassium	Calcium
Baldwin apple:	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Fruit	2.8	0.6	5.7	0.3
Leaves	18.4	1.2	3.5	22.0
New wood	9.2	1.5	3.8	1.8
Grapes:				
Fruit	8.2	1.6	13.0	----------
Leaves	16.9	1.4	10.0	----------
New wood	5.4	.7	4.5	----------
Raspberries:				
Fruit	12.1	2.5	13.0	----------
Leaves	23.3	2.0	9.0	----------
New wood	7.6	1.0	4.1	----------
Garden peas:				
Seeds	44.5	4.8	14.3	1.0
Leaves	38.5	2.2	28.4	15.4
Vines	12.2	1.1	30.0	----------
Beets:				
Roots	31.0	2.7	52.0	1.6
Tops	30.0	3.2	41.2	21.4
Wheat:				
Grain	23.0	4.1	5.4	.5
Straw	6.0	1.2	4.8	2.1
Oats:				
Grain	18.8	2.8	4.0	10.1
Straw	5.3	.9	9.3	3.0
Corn:				
Kernels	18.8	2.8	3.2	.3
Leaves and stalks	11.5	1.9	16.0	4.3

Magnesium.—Magnesium is a constituent of chlorophyll, the green pigment of growing plants. Without chlorophyll plants can not assimilate the carbon dioxide of the air—the source of all carbon which a plant builds into its tissues. Magnesium accumulates in the seeds, fruit, and flowers of plants to a greater extent than does calcium, but much less than calcium in stems, leaves, and wood. It usually is not considered an element necessary to supply to crops in fertilizers, although frequently used as an ingredient of potash salts in mixed fertilizers. In some localities, however, lack of proper nutrition manifested by certain plants has been shown to be due to insufficient magnesium. An example is the "sand drown" of tobacco on certain sandy soils.

Sulphur.—Sulphur is an ingredient of protein material, and without it there can be no plant growth. It is also an ingredient of oils found in certain plants that give them their distinctive taste or odor, such as mustard, horse-radish, and onion. The quantity found in plants as well as the quantity actually required is small. The quantity of sulphur in soils is smaller than that of any other necessary plant-food element, and some crops may suffer for lack of this element. Beneficial results have been obtained in some localities from applications of sulphur. In some sections sulphur in the form of calcium sulphate has been extensively applied to soils, incidentally in acid phosphate, this fertilizer ingredient containing a considerable quantity of this salt.

Lime Requirements

The term "lime requirements" may be used in two senses as applied either in the laboratory or the field.

In the first sense it means the quantity of lime that must be added to a soil to make it slightly alkaline. This is determined by some laboratory or analytical determination and can only indicate that the soil examined may need lime. The analysis can be confirmed and the quantity necessary determined by field test.

Lime requirement in a field sense means the quantity of lime necessary to bring increased crop yields. The requirement in both cases is usually stated in tons of lime per acre.

Litmus-Paper Test.—Litmus paper is an absorbent paper saturated with red, blue, or neutral litmus. Red litmus paper in contact with alkalines turns blue, and vice versa; blue litmus in contact with acid turns red. Blue litmus paper can be used as a rough test for acid soils either in the field or in the laboratory.

The test usually is made by moistening the soil to form a compact mud, making an opening in this, inserting a strip of blue litmus paper, closing the soil around it, and allowing it to stand for a short time, and then noting any change in color. A modification of this method that has some advantage is as follows: The moistened strip of litmus paper is placed on the side or bottom of a glass or beaker, and the dry soil then introduced into the glass, moistened thoroughly, and allowed to stand. Any change of color of the litmus paper can be observed through the glass, and modification of the color of the paper by adhering soil particles is prevented.

A mere bleaching of the blue paper or leaching by soil moisture should not be mistaken for a change to red. To prevent this no more water should be used than is necessary to moisten the soil thoroughly. The litmus-paper test, except in extreme cases, will not show dif-

ferences in soil acidity. A great many soils that do not show an acid reaction with litmus paper have a high lime requirement; that is, they require an application of a considerable quantity of lime before they will show an alkaline reaction with red litmus paper.

What Should Not be Expected of Liming.—Liming will not take the place of drainage. High acidity of some marsh soils is caused by poor drainage. Liming can improve only the conditions in the upper soil, making for better circulation of air and water. Impervious layers or hardpan should be broken up.

Liming can not take the place of proper crop rotation, cultivation, or soil management. In fact, the use of lime makes it more necessary that rotation and all cultural methods be given attention.

Lime does not supply any of the elements furnished by fertilizers—nitrogen, phosphorus, or potassium. The use of lime may enable the farmer to grow crops with less fertilizer, or in an emergency to do without it altogether for a short time.

Good results should not be expected from the application of lime to a soil deficient in organic matter. Likewise, it should not be expected to build up such a soil unless organic matter is supplied either in manure or in green crops that are plowed under.

Influence of Acid Soil Conditions on Crops.—In judging whether it is advisable to lime and how much lime to apply, consider the crop to be grown quite as much as the degree of acidity in the soil. The more important crops may be divided into five groups, ranging from those that grow best on soils sufficiently supplied with lime (Group 1) to those that seem to favor acid soil (Group 5).

Group 1.—Sweet clover, alfalfa, beets, lettuce, onions, celery, asparagus, cabbage, cauliflower, spinach, red and mammoth clovers.

Group 2.—Timothy, blue grass, wheat, barley, cucumbers, pumpkins, kale, peas, kohl-rabi, Brussels sprouts, buckwheat, crimson and alsike clovers.

Group 3.—Beans, sword beans, velvet beans, cowpeas, carrots, corn, oats, rye, cotton, potatoes, tomatoes, redtop, turnips.

Group 4.—Flax, apples, millet, radishes, vetch.

Group 5.—Blueberries, cranberries, blackberries, Lima beans, bent grasses, fescues, strawberries.

The plants in Group 5 usually respond little to liming, even in quite acid soils; some of them may even be injured by moderate liming. Those in Group 1, on the other hand, will not make a successful growth on moderately acid soils; they respond markedly to liming, and should receive heavier applications of lime on the same soil than Groups 2, 3, or 4. Groups 2, 3, and 4 are intermediate between 1 and 5 with respect to need of liming and quantity of lime to apply.

15. WEATHER

.0 General.
.1 Weather and crops.
  .10 General.
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    .113 Cultivating.
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WEATHER

WEATHER AND CROPS

Many things affect the farmer in his work, but the weather is usually of greatest concern to him, on account of its direct influence on farm work and crop growth. There are numerous weather risks that the farmer has to take. Either continued wet weather or drought may interfere with planting and cultivation or damage crops during the growing season. Frost in a single night may seriously harm or completely destroy growing plants, or hail in a few minutes lay waste a promising yield. The weather influence begins with the preparation of the soil for planting, and does not terminate until the crop is safely garnered. During this entire time the farmer is, so to speak, at the mercy of the weather.

In a study of the relation of climate to agriculture two general divisions of farm land may be made, on a basis (1) of moisture alone and (2) of temperature and moisture combined. In the first division, agriculture is considered from the standpoint of the general suitability of the land for growing crops of any kind without the employment of special methods, such as so-called dry farming, or by artificially supplying moisture by irrigation; the other subdivides the larger areas more or less specifically by crops, such as the Corn Belt, the Cotton Belt, and other similar groupings.

Geographic Distribution of Crops

Corn.—This is a sun-loving, warm-weather crop, in general thriving best where summer rainfall is ample and the nights as well as the days are warm. The principal producing sections in the United States have a frostless season of at least 140 days, a mean summer temperature of 70° to 80° F., and an annual precipitation between 25 and 50 inches. July usually is the most critical month, when growth has reached the tasseling and ear-forming stage and ample moisture is necessary.

Wheat.—This crop is best suited to temperate regions having a growing season of at least 90 days and moderate rainfall. It is most extensively cultivated where the annual precipitation is less than 30 inches. There are two general varieties of wheat, the winter variety being best suited to sections where the normal winter temperature (December–February) is above 20° F., and the spring variety where the winters are normally colder, with light snowfall.

Oats.—This crop thrives best in cool, moist climates. It requires moderately low temperatures, especially when the heads are developing and filling. In warmer climates oats is a winter crop.

Rye.—This is a typical cool-weather crop. It can be sown late in fall, and will grow where the winters are too cold for wheat.

Barley.—This crop has a short period of growth, and consequently can be produced where the growing season is too short for corn. The temperature range of barley is wider than for any other cereal.

Buckwheat.—This crop grows best where the summers are cool and moist; the mean summer temperature should not be much over 70° F. for best results.

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Grain Sorghums.—These crops are more or less drought resistant and are best suited to a dry, hot, and sunshiny climate, such as prevails in the southern Great Plains area.

Potatoes.—Because of their cool-weather requirements, potatoes make their best development in the northern and western parts of the United States, where the mean annual temperature is between 40° and 50° F. and the mean for July not over 70°. In the warmer climates potatoes should be grown in the cooler season of the year, to escape the unfavorable warm summer weather.

Cotton.—This crop is of tropical origin and requires a mean summer temperature of about 78° F. and a frost-free season of about 200 days in length. The growth of cotton is limited more by temperature than by rainfall, the annual precipitation varying in the Cotton Belt from about 25 to 50 inches. Cotton requires abundant sunshine and only a moderate degree of moisture. In the central and eastern portions of the belt the cotton crop is frequently damaged by too much moisture, and in the more western portion by summer droughts.

Rainfall and Types of Farming

The amount of moisture required by crops for their best development varies for different localities and for different crops. The minimum quantity of rainfall needed under favorable seasonal distribution for ordinary farming methods of diversified cropping is usually considered to be from 15 to 20 inches annually. Modifying influences which must be taken into account are (1) soil texture as affecting its moisture-retaining qualities, (2) temperature conditions, and (3) rate of evaporation. In general, crops can be grown with a smaller quantity of rainfall in cooler climates than in warmer regions.

Considered as to its moisture in relation to agriculture, the United States may be divided into an eastern and a western half. Broadly speaking, 15 inches of annual rainfall may be regarded as the minimum precipitation required for ordinary farming in the more northern portions of the United States, 20 inches in the central, and 25 inches in southern sections. These minimum quantities occur along the one hundred and first meridian. In the transition zones between the humid East and the semiarid West crops more or less drought resistant, such as the grain sorghums, usually do best in the warmer regions, and the hardier grain crops, such as wheat, in the cooler.

Temperature and Crops

Wheat and oats thrive with lower temperature than does corn, which in turn requires less warmth than cotton. Thus some crops may not only be planted earlier in spring than others, but can be grown in cooler climates. Spring wheat may be seeded in cooler weather than any other major spring crop. Seeding usually begins in the Dakotas and in Nebraska when the normal daily temperature rises to 37° F., and in Minnesota and Wisconsin at 40°. Next in thermal order comes spring oats, the seeding of which may begin when the normal daily temperature rises to 43°. Early potato planting begins, as a rule, at 45°, and corn at 55°. The corn-planting date in any locality corresponds closely to the average date of last killing frost in spring. Cotton planting should not begin until the normal daily temperature rises to about 63°. The date on which this temperature is reached corresponds closely to the latest date in spring on which killing frost has occurred.

Critical Periods of Growth and Weather Influence

Vegetables.—Vegetables in their relation to climate may be divided into three general groups: (1) Those which require a comparatively large amount of heat and thrive best where the growing season is warm; (2) those which prefer intermediate temperature conditions; and (3) those best suited to regions where the growing season is comparatively cool, or grow best in warm climates during the cooler period of the year. The designations "hardy" and "tender" are usually applied, respectively, to those crops which are able to withstand ordinary frost in spring without injury, and to those which would be killed if subjected to the same temperature. The difference in temperature requirements for the several vegetable crops is so pronounced that some of the cool-weather varieties may be planted as much as a month or more before it is safe to put out others requiring more warmth.

Although the hardy vegetables may safely be planted before the danger from frost is over and the tender varieties can not, the weather influence is more far-reaching than this, because many of the so-called hardy vegetables would suffer nearly as much from the heat and drought of summer as the others would from light frost in spring. Some of the vegetable crops demand cool weather during the entire period of growth, and without it will not produce well. For others cool weather is necessary during the early development, but when once well established they will continue to develop and to mature satisfactorily with relatively high temperatures. Furthermore, the danger of frost injury in spring is only one reason why tender crops should not be planted early. They do not germinate well in cool soil, and even if there should be sufficient warmth for germination and emergence, the normally cool weather of early spring would preclude proper growth and development.

Warm-weather crops, such as snap beans, okra, tomato plants, Lima beans, pepper plants, eggplants, cucumbers, melons, squash, and sweet potatoes, should not be planted in the open, as a rule, until two weeks (for some crops more) after the average date of last killing frost in spring. Snap beans, okra, and tomato plants may be put out somewhat earlier than the others. The intermediate-weather crops, such as beets, parsnips, carrots, lettuce, salsify, celery seed, onion seed, parsley, sweet corn, and Chinese cabbage, may be planted about the average date of last killing frost in spring. Sweet corn will grow where it is ordinarily too cool for field corn.

The typical cool-weather crops, such as early cabbage plants from coldframes or hotbeds, radishes, collards, onion sets, early sweet peas, kale, early potatoes, turnips, and mustard, may usually be planted about two weeks before the average date of last killing frost in spring. In warmer climates these should be grown in the cooler season of the year.

Fruit.—The principal weather risk of fruit growers in the United States is the occurrence of frost, particularly in spring. Frost damage to fruit in the United States is relatively much greater than to any other crop. Most fruit trees respond readily and rapidly to short periods of abnormal warmth in early spring, and consequently a warm spell of weather in that season may cause premature development of buds and blooms, to which a later cold period may be destructive.

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There is, as a rule, a close margin of time between the average date of the last freeze in spring and that when fruit is in full bloom. In 40 per cent of the years, the temperature drops to freezing or lower after the apple trees are in full bloom.

The low-temperature danger point for fruit blossoms or for the fruit when setting varies only slightly for different varieties, and ranges for most fruits from 27° to 30° F., though for plums and prunes it is generally about 31° and for apricots about 32°.

To most deciduous fruits an injurious frost or freeze will cause much greater permanent damage after the fruit has set than during the bud or the blooming period, and the later the frost after the setting of fruit the greater the danger. In an average year the larger tree fruits should lose from 75 to 90 per cent of the buds or blooms for best results. This fact causes many orchardists to overestimate the amount of damage to their crop after a spring frost.

There is great advantage to be had in selecting the location for an orchard with respect to local topography. In general the lower ground, especially small inclosed valleys, should be avoided. Such locations are much more liable to have frost than higher or sloping ground, because of air drainage, whereby a mass of dense, cold air collects over the lower ground during clear, calm nights. The difference in susceptibility to frost on slopes and bottom lands is often very pronounced. It frequently happens that the trees on the higher ground of an orchard may escape while those on the lowlands are frosted. In fact, the danger line is sometimes so sharply drawn that the blossoms on the lower branches of individual trees are killed while those on the upper branches are unharmed.

WEATHER FORECASTS

Weather forecasts and warnings are based upon simultaneous observations of local weather conditions taken at 8 a. m. and 8 p. m., seventy-fifth meridian time, at about 200 regular observing stations representing geographically all sections of the United States, and similar reports received from points in the West Indies, Hawaiian Islands, Alaska, Canada, Bermuda, and a few other parts of the Northern Hemisphere. Each Weather Bureau station is operated by one or more trained observers and is equipped with mercurial barometers, thermometers, wind vanes, rain and snow gauges, anemometers, and other instruments, which make a continuous automatic record of local weather conditions and changes. The reports are sent immediately by telegraph to the district centers located at Washington, Chicago, New Orleans, Denver, and San Francisco. The system of distribution is so arranged that the principal stations in the United States receive reports from a sufficient number of others to represent the weather conditions over a large part of the country. The telegraphed reports are charted, and the forecasts and warnings based thereon are distributed in less than two hours from the time of the observations.

Forecast Centers

The States comprised within the five forecast districts, with the district centers, follow:

Washington, D. C.: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, District of Columbia, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Kentucky, and Ohio.

Chicago: Michigan, Indiana, Illinois, Missouri, Iowa, Wisconsin, Minnesota, North Dakota, South Dakota, Nebraska, and Kansas.

New Orleans: Louisiana, Arkansas, Oklahoma, and Texas.

Denver: Colorado, Utah, New Mexico, Arizona, Wyoming, and Montana.

San Francisco: Washington, Oregon, Idaho, Nevada, and California.

Daily Forecasts

The forecasts issued each morning are telegraphed to about 1,100 principal distributing points, and thence further disseminated by telegraph, telephone, and radio to every community in the country that can be reached thereby. They are furnished also to press associations and newspapers, and are published by practically every daily newspaper in the United States. The forecasts made at night are distributed mainly through radio broadcasts and publication in morning papers. Those issued in the morning are for 24 hours beginning at 8 p. m. of the day of issue, and those issued at night are for 36 hours beginning at 8 a. m. the next morning.

Weather maps or weather bulletins are issued in the forenoon of every week day except national holidays, and

are distributed for public display in every community that can be reached by mail on the day of issue. These contain reports of weather conditions at 8 a. m. throughout the country, other meteorological information, and the weather forecasts.

For many years farmers were at a disadvantage in obtaining the benefits of the forecasts and warnings of the Weather Bureau, because they were inaccessible to systems of communication whereby they could receive the information promptly. The development of rural telephone lines and the rural mails has helped a great deal to remedy this situation. Radio, too, is filling this gap, and already the forecasts and warnings are being broadcast on fixed schedules in nearly every State. A system has been developed whereby farmers in practically all parts of the country will be in range of a radio station which disseminates forecasts applicable to their locality. The State section directors of the Weather Bureau will furnish schedules of broadcasts in their respective States upon request.

Weekly Outlook

This is issued on Saturday from the district forecast centers, giving an outlook of general weather conditions to be expected during the succeeding week (Monday to Saturday, inclusive).

Harvest-Weather Forecasts

The regular daily forecasts cover periods 36 to 48 hours in advance, but the harvest-weather forecasts go just as far ahead as the forecaster feels that he can give reasonably reliable information, frequently as much as four days. They are so worded as to indicate the degree of confidence that the forecaster has in the predictions. For instance, in a three-day forecast he may feel certain regarding the ensuing weather during the first 24 hours, but not so sure about the second period, and doubtful regarding the last day. An example of such a forecast is: "Good drying weather Tuesday, and strongly indicated for Wednesday; Thursday unsettled, probably rain." Thus the farmer is able to weigh the forecasts in connection with his work at hand and to plan accordingly.

The harvest-weather forecast work at the present time is conducted only in New York State in cooperation with county agents. Forecasts are telegraphed directly from the Weather Bureau office issuing them to distributors selected by the county agents (usually employees of the rural telephone exchanges), who make them available at designated hours to all farmers on the telephone lines.

Fruit Spraying

A special fruit-spraying service is operated in several of the important fruit-growing districts. It consists in the issuing of special weather forecasts as a guide in the application of sprays to trees. It is well known that the efficiency of sprays, both as insecticide and fungicide, is largely determined by their being applied under proper weather conditions. Therefore it is important that the orchardists have correct information as to coming weather conditions, and the economic value of such information is enormous. The forecasts are made for just as long a period in advance as conditions shown on the weather map warrant, sometimes as much as four days. The predictions of longer periods are especially important to owners of large orchards, some

of whom require two or three days to make one application of spray. This service is also conducted in cooperation with county agents. Forecasts are telegraphed to central points in the fruit districts and distributed to the orchardists by telephone and otherwise.

Shippers' Forecasts

These are issued during the winter months at all stations located in commercial centers, and contain predictions of minimum temperatures expected within the following 24 to 36 hours along the railroads running in various directions from these cities. They are intended as a guide in the shipment of products subject to damage from freezing while in transit. Similar forecasts are issued in the summer time when temperatures in excess of 90° F. are expected. These forecasts are made by the officials in charge of the Weather Bureau field offices located in the commercial centers. Storm and hurricane warnings are issued primarily for the benefit of ship navigation. They do not affect farming activities except incidentally in coastal regions, where high tides and heavy rainfalls accompanying storms and hurricanes inundate agricultural lands.

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SPECIAL WARNINGS

Cold Waves

These warnings are issued from 24 to 36 hours in advance, and in addition to being given the same distribution as the daily forecasts, are telegraphed and telephoned to extensive lists of commercial enterprises affected thereby, and are indicated by the display of a special flag. These warnings are especially valuable to railroads in the making up of trains and the maintenance of schedules; to the shippers of perishable goods, nurserymen, florists, cattle interests, and to farmers in connection with many farm operations outside of the growing season.

Frost Warnings

These warnings are especially necessary where facilities for the protection of crops are available, and are extensively used by truckers, by horticulturists, and by growers of tobacco, cranberries, sugar cane, and citrus fruits. There are many ways in which frost warnings are used in the saving of crops when no protective appliances are available, and where covering of the vegetation, heating, or other methods of warding off frosts are not practicable. Beans, grapes, and other vegetables and fruits can be picked; tobacco and unmatured corn and sugar cane can be cut; and young potato, cabbage, and other plants covered by plowing. These warnings are distributed in the same manner as the weather forecasts and by special telegrams to designated distributors, county agents, and others, who notify individual growers in their districts. Special attention is given to the broadcasting of the warnings by radio stations within range of the sections in which the frosts are expected.

Floods

Flood warnings enable the farmer to remove portable property, including livestock, beyond the reach of the flood waters, and to take any other necessary action. Frequently in the late summer or fall some crops are left standing on the lowlands exposed to flood waters, and when warnings are issued these may be moved to places of safety. In the South thousands of cattle are pastured in the swamp lands, where they can feed throughout the year unless driven out by floods, which in that section are rather frequent. The flood warning enables the farmer to drive the cattle to higher ground and to provide food for them while the flood continues.

Forecasts of the stages of water to be expected are made daily along the larger rivers as an aid to inland navigation. The loading of boats depends on the stage of water. Low water means light cargoes and delay, with consequent decrease in receipts and increase in expense of operation, much of which would be reflected back to the farmer if the daily river forecasts did not enable the transportation interests to adjust themselves to the changing situation.

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The measurement of the snowfall in the mountain regions of the West, the determination of its water equivalent in the late winter and early spring, and the forecasts of the quantity of water that will be available for irrigation and power during the coming season are of great value to both agricultural and commercial interests. The farmer or rancher, knowing how much water will be available, can plan his planting accordingly, and the power companies also are supplied with valuable advance reports.

Miscellaneous Service

There are many special services given to specific industries and enterprises occasionally or during fixed seasons, according to their necessities. Among them may be mentioned special forecasts for the alfalfa-seed growers in some of the Western States, where the quality of the seed is enhanced by the plants being allowed to remain uncut until a certain point of maturity is reached and the growers are dependent upon accurate forecasts of rains or frosts in determining whether or not the crop should be saved by cutting before that time; in the forecasting of rain for the raisin growers of California during the drying season to avoid damage or destruction from wetting; in the issuing of warnings of cold rains, snow, or sleet in protecting sheep in the shearing and lambing season; advices to ice harvesters; heavy snow warnings for the benefit of shippers and users of the highways in the marketing of farm and other products; and forecasts and warnings as an aid in preventing and controlling forest fires.

The Weather Bureau is desirous of close and cordial cooperation between its officials in charge of field stations and county and field agents of national and State agricultural organizations. Requests for forecasts, warnings, and weather maps may be made to the nearest Weather Bureau office or to the section director of the State, who is as a rule in the better position to give advice and information. These section centers are indicated in the climatic tables.

FROST PROTECTION FOR FRUIT

The frost hazard to fruits and vegetables is very great, especially to fruit, and since promising crops may be destroyed in a single night various methods of protection against frost are practiced.

Principles of Protection

Three general principles are used in frost protection: (1) Conserving heat, (2) mixing or stirring the air, and (3) adding heat. The best method of protection depends on the character of the crop and on local conditions. Considerable heat may be conserved by providing a suitable cover for the ground or plants. Glass is best for this purpose, but too expensive for general use. Heavy cloth or paper laid directly over low plants is effective against moderate frost, but tin cans or other metal coverings should not be used. Small truck sometimes is protected by a furrow plowed between the rows and covering the plants with soil. Spraying has been attended with some success on truck and vegetables, but is dangerous to fruit when frost is severe, as heavy ice may form.

The temperature of the air a short distance above the ground on frosty nights is often from 7° to 10° higher than near the surface. Therefore, if the lower cold air could be mixed with the warm upper air damaging frosts would be averted. Attempts have been made to do this with various devices, such as power-driven fans, but it has been found that the expense is too great for practical use and the results are not so satisfactory as those obtained by some other methods. Adding heat to the lower air to replace that lost by radiation and conduction usually is accomplished by means of a large number of small fires. Oil, wood, coal, oil-soaked shavings, carbon briquets, or a combination of these may be used. A large number of small fires is more efficient than a small number of large ones. This method has been found the most economical and effective, especially where protection is undertaken on an extensive scale. It is almost exclusively used in the western fruit-growing sections, where heating is practiced very extensively. The fuel usually is a cheap grade of oil consumed in specially constructed but inexpensive burners, 50 to 120 per acre, depending on the degree of cold expected and the type of burner used. Many other devices have been tried, with varying but mostly unsatisfactory results.

A smoke screen has very little protective value, and the effect of smudge fires of damp straw or manure or of smoke screens from chemicals is far less than that of direct heating, while the chemical smoke screens that have been tried so far are much more expensive. Smoke has some value, however, about sunup in shading the plants and blossoms and thus preventing a too rapid thawing.

Does Orchard Heating Pay?—This question can be answered only with a knowledge of prevailing local conditions, as the factors to be considered vary greatly, even sometimes for orchards in the same locality. The

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principal questions are whether or not the value of the fruit lost through frost damage will more than pay for the necessary operating expenses, together with interest and depreciation charges on the investment, and whether the locality is likely to be visited by short periods of cold weather during the critical season that would be too severe to combat successfully by known protective methods. Usually the temperature in an orchard can not be raised more than 6° or 8° under the most favorable atmospheric conditions. There are two cases where orchard heating will not pay: (1) Frost damage may be too infrequent to warrant the expense of heating, and (2) the orchard may be exceptionally cold because of local topography, so that damaging frosts occur so often that the cost of protection is too great to be carried by the crop. Some practical citrus growers consider it a good business practice to have frost-fighting equipment when it is necessary to use it only one year in five.

Temperature Surveys

The Weather Bureau conducts temperature surveys in fruit districts in several parts of the country by which the temperature relation between various sections having different topographic features is determined. These surveys supply information as to the suitability for fruit growing in relation to the frost hazard. Numerous substations are maintained in some of the principal fruit areas, especially in the more western States, during the danger period of the year, and a few trained meteorologists are assigned to this work. Daily local forecasts are distributed to producers and advices given as to the necessity for putting into operation the protective measures. Considerable experimental work is also done for the purpose of determining the most economical and efficient methods of protection against frost for the information of those interested in the subject.

WEATHER AND CROP SERVICES

The farmer's working partner, so to speak, is the weather, and it is essential that he and all others interested in the important problem of supplying the Nation with food keep in close contact with prevailing weather conditions and their effect on farming operations and growth of crops in different sections. To supply this need special weather and crop services are operated by the Weather Bureau, through which such information is made available to all interested persons. Two services, more or less distinct, are maintained—one daily and the other weekly.

Daily Cotton and Grain Region Services

To meet the need for more detailed information than can be given on the daily weather map as to temperature, rainfall, drought, and floods in the staple crop-growing districts, special cotton and grain region services are operated during the growing season of the principal crops. Observations are made each morning by special meteorological observers at about 400 stations in the principal agricultural regions, and the data are telegraphed to central Weather Bureau stations designated district centers. Daily bulletins are published at 36 centers, each containing weather data for the near-by substations.

The cotton-region service covers, wholly or in part, the States of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Texas, Oklahoma, Arkansas, Tennessee, and Missouri. The district centers are located at Wilmington, N. C., Charleston, S. C., Atlanta, Augusta, and Savannah, Ga., Mobile and Montgomery, Ala., Vicksburg, Miss., New Orleans, La., Houston, Tex., Oklahoma City, Okla., Little Rock, Ark., and Memphis, Tenn.

The grain-region service covers the following States: Kentucky, Ohio, Indiana, Illinois, southern Michigan, southern Wisconsin, Minnesota, Iowa, Missouri, northern Oklahoma, Kansas, Nebraska, South Dakota, North Dakota, and Montana. The district centers are located at Louisville, Ky., Columbus, Ohio, Indianapolis, Ind., Chicago, Ill., Minneapolis, Minn., Des Moines, Iowa, St. Louis, Mo., Oklahoma City, Okla., Kansas City, Mo., Omaha, Nebr., Huron, S. Dak., Bismarck, N. Dak., and Helena, Mont.

Weekly Range and Cattle Service

Because of the large expanse of the western grazing country some sections of the area may have severe drought and others ample moisture to supply sufficient food for livestock and some to spare. It then may become necessary to ship stock from unfavorable to more favorable regions. Again, bankers and others who lend money on livestock require information as to weather conditions and their effect on the range and stock throughout the grazing area. To meet these needs a cattle-region service is maintained, through which reports are received each week from special observers in different sections of the grazing area as to prevailing weather conditions and

their effect on the range and livestock. These reports are published as weekly bulletins at designated central stations in the range country. The cattle-region centers are located at Amarillo, Tex., Phoenix, Ariz., Salt Lake City, Utah, and Cheyenne, Wyo.

Weekly Weather and Crop Service

In this service the officials in charge at designated central Weather Bureau stations in each State collect information weekly from many special and cooperative meteorological observers and from a large number of weather and crop correspondents in the respective States relative to prevailing weather conditions and their effect on farming operations and crop development. These officials make weekly telegraphic reports to the central Weather Bureau office at Washington, D. C., where the information is tabulated and summarized and a synopsis issued for the entire country. This is released each Wednesday at 10 a. m. and is published in the "Weekly Weather and Crop Bulletin," which includes meteorological tables and charts showing graphically the precipitation and temperature conditions throughout the country during the preceding week.

In addition there is published a local weather and crop summary at each State center containing information in more detail as to conditions prevailing in the respective States. There is also published at New Orleans a "Weekly Cotton-Region Bulletin" covering conditions in the Cotton Belt as a whole, and at Chicago a similar report pertaining to the principal grain-producing States.

Application for the "Weekly Weather and Crop Bulletin" for the several States should be made to the section center for each, a list of which will be found under the heading "Climatological Service." The cattle-region bulletins may be had by application to the stations issuing them, and requests for the cotton and corn and wheat region bulletins should be made to the several district centers, all of which are listed above. Correspondence with any station should be addressed to the official in charge, Weather Bureau office.

Many circulated stories and rumors that affect the price of grain and other agricultural products and the agricultural industry in general relate to the weather. By maintaining these services the Weather Bureau supplies dependable information at frequent intervals, whereby the public is kept informed as to actual conditions.

CLIMATOLOGICAL SERVICE

The regular observing stations of the Weather Bureau, about 200 in number, provide sufficient information for making the usual daily forecasts, but a proper knowledge of the main climatic features of all parts of the country must be based on observations from a far larger number of points well distributed over all the States.

Reporting Stations

As payment of so large a number of observers is not possible from the Weather Bureau funds, voluntary cooperation has been solicited. As a result nearly 5,000 observation stations for recording the elements of temperature, precipitation, wind, and weather on a cooperative basis are now in operation, and are so well distributed that the main climatic features of any portion of the country can be determined with moderate accuracy. The Weather Bureau furnishes the necessary instruments with which to make the required observations, and the records are entered on specially prepared forms which the observers forward monthly to proper centers free of charge.

Section Centers

To carry forward this work the climatological service of the Weather Bureau has been placed under the general supervision of the climatological division of the central office at Washington, with a branch office, known as the section center, in each State, usually at one of the regular Weather Bureau stations. A list of the important stations is given in the following table of climatic data, and the section centers for the respective States are indicated. The New England States are combined into a single section, with the center at Boston, and Maryland and Delaware are likewise combined, with the center at Baltimore.

Current Publications

The reports made by the cooperative observers, together with those from the regular stations, are gathered monthly at the State centers, where they are carefully examined and the data arranged in suitable tables. These are summarized according to the leading features of the weather for the month, compared with normal conditions determined from the records of other years, and all published in convenient form for reference under the title "Climatological Data." They may be obtained from the State center free of charge by Government officials, including cooperative extension agents.

In addition to these regularly issued publications, there have been prepared convenient monographs giving the important weather features of small areas, usually several for each State, the number depending on the size of the State and the whole making up a series of 106 separate parts covering the entire country. These contain extensive tables showing in detail the monthly and annual precipitation at practically every observing station in the

section that has a record of 10 years or more from the beginning of observations to the date of publication, and in addition summarized statistics of temperature, wind, snow, humidity, sunshine, frost, and other data pertaining to the weather of the section. These may be procured for the State or portions thereof, usually without charge, from the State center. The entire set, unbound, is for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C., at a cost of $3.

Snow Reports

In addition to the publications referred to above, the climatological division issues at Washington a weekly bulletin on the snow and ice conditions throughout the country during the winter season, usually from early December till the latter part of March, which may be had free of charge.

There also are issued during the winter season, at least for the latter part, monthly statements of snow conditions in the western mountain States, where the amount of snow stored in the high mountains at the close of the winter is an essential factor in meeting the problems of irrigation and water power during the warm months of the year, when rainfall is insufficient. Copies of these likewise may be had free of charge from the State centers.

Miscellaneous

For early information concerning the weather of the month rather full summaries are issued promptly at the close of each month at the important stations, which include practically all those shown in the table of climatic data. These are furnished free to anyone interested in getting information concerning the weather for the month just closed. Persons desiring weather information may usually obtain it promptly by request upon the section director of the State for which desired. If convenient, it is best to visit personally a near-by station and to consult with the official in charge, who usually has a wide personal knowledge of the weather in the various parts of the country and is prepared to advise as to the suitability of the climate to the needs of the inquirer.

CLIMATIC TABLES

Climatic tables

Stations	Average precipitation: Annual	Average precipitation: Warm season, April to September	Average temperature: January	Average temperature: July	Killing frost: Average date of last in spring	Killing frost: Average date of first in fall	Killing frost: Average days in frost-free season
Alabama:	*Ins.*	*Ins.*	*°F.*	*°F.*			
Anniston	49. 36	23. 34	42. 2	77. 9	Mar. 24	Nov. 1	222
Birmingham	49. 48	23. 32	45. 1	80. 2	Mar. 16	Nov. 9	238
Mobile	62. 04	33. 17	51. 5	81. 4	Feb. 17	Dec. 5	291
Montgomery [1]	51. 16	24. 08	48. 2	81. 7	Mar. 10	Nov. 11	246
Arizona:							
Flagstaff	22. 82	10. 16	26. 7	65. 0	May 31	Sept. 24	116
Phoenix [1]	7. 87	3. 62	51. 2	89. 8	Feb. 16	Dec. 3	290
Yuma	3. 10	0. 76	54. 4	90. 8	None.[2]	None.[2]	----
Arkansas:							
Fort Smith	41. 34	23. 48	39. 5	81. 5	Mar. 21	Nov. 6	230
Little Rock [1]	49. 89	24. 60	40. 6	80. 6	Mar. 18	Nov. 14	241
California:							
Fresno	9. 68	1. 71	46. 2	82. 1	Feb. 22	Dec. 2	283
Los Angeles	15. 64	1. 74	54. 6	70. 2	None.[2]	None.[2]	----
Red Bluff	25. 08	4. 45	45. 8	80. 8	Mar. 10	Dec. 6	271
Sacramento	20. 09	3. 53	45. 8	73. 2	Feb. 19	Nov. 29	283
San Diego	10. 01	1. 24	54. 3	67. 2	None.[2]	None.[2]	----
San Francisco [1]	22. 27	3. 10	49. 9	58. 5	Jan. 25	Dec. 10	319
San Luis Obispo	20. 61	2. 96	51. 6	64. 7	Mar. 3	Nov. 18	260
Colorado:							
Denver [1]	14. 02	10. 03	29. 8	72. 2	May 4	Oct. 8	157
Durango	20. 01	9. 25	24. 5	68. 7	May 20	Sept. 26	129
Grand Junction	8. 30	4. 57	24. 0	77. 7	Apr. 19	Oct. 19	183
Pueblo	11. 95	8. 74	29. 9	74. 2	Apr. 27	Oct. 8	164
District of Columbia:							
Washington	43. 50	23. 90	33. 4	76. 8	Apr. 8	Oct. 20	195
Florida:							
Jacksonville [1]	53. 25	32. 94	55. 4	82. 1	Feb. 16	Dec. [illegible]	293
Miami	59. 52	38. 25	66. 5	81. 0	None.[2]	None.[2]	----
Tampa	53. 13	37. 54	60. 4	81. 2	Jan. 26	Jan. 3	342
Georgia:							
Atlanta [1]	49. 36	23. 34	42. 6	78. 1	Mar. 31	Nov. 7	221
Augusta	47. 89	25. 83	47. 0	81. 3	Mar. 22	Nov. 10	233
Macon	44. 88	22. 73	46. 8	81. 2	Mar. 23	Nov. 7	229
Savannah	50. 34	31. 26	51. 4	81. 5	Feb. 26	Nov. 24	271
Thomasville	50. 47	26. 98	51. 0	81. 8	Mar. 14	Nov. 15	246

[1] State section center.
[2] Killing frost too infrequent to obtain reliable averages.

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Climatic tables—Continued

Stations	Average precipitation		Average temperature		Killing frost		
	Annual	Warm season, April to September	January	July	Average date of last in spring	Average date of first in fall	Average days in frost-free season
Idaho:	*Ins.*	*Ins.*	*°F.*	*°F.*			
Boise [1]	12.71	4.10	29.8	72.9	Apr. 27	Oct. 12	168
Lewiston	13.48	5.24	32.5	74.0	Apr. 5	Oct. 25	203
Pocatello	13.88	6.47	24.7	70.8	May 1	Oct. 6	158
Illinois:							
Cairo	41.71	20.56	34.9	79.6	Mar. 31	Oct. 29	212
Chicago	33.28	19.45	25.1	73.9	Apr. 18	Oct. 18	183
Peoria	36.29	20.86	23.6	74.3	Apr. 15	Oct. 19	187
Springfield [1]	36.96	21.18	26.5	76.5	do	do	187
Indiana:							
Evansville	43.36	22.06	33.5	78.9	Apr. 6	Oct. 27	204
Fort Wayne	37.15	20.69	26.5	73.9	Apr. 17	Oct. 21	187
Indianapolis [1]	41.48	22.23	28.4	75.7	Apr. 16	Oct. 19	186
Terre Haute	38.89	21.34	30.5	77.5	Apr. 14	Oct. 22	191
Iowa:							
Charles City	31.23	22.67	13.7	72.3	Apr. 30	Oct. 7	160
Davenport	32.69	21.51	21.8	75.3	Apr. 22	Oct. 14	175
Des Moines [1]	32.45	23.04	20.1	75.4	Apr. 21	Oct. 10	172
Dubuque	34.01	22.72	19.1	74.1	Apr. 20	Oct. 15	178
Keokuk	35.07	23.18	24.9	76.9	Apr. 14	Oct. 13	182
Sioux City	25.96	20.10	17.8	74.3	Apr. 27	Oct. 2	158
Kansas:							
Concordia	27.47	21.10	26.4	78.0	Apr. 17	Oct. 17	183
Dodge City	20.84	16.27	29.0	78.4	Apr. 21	Oct. 21	183
Iola	37.63	26.63	29.8	78.2	Apr. 7	Oct. 23	199
Topeka [1]	33.76	25.11	27.6	77.8	Apr. 10	Oct. 17	190
Wichita	30.61	22.25	31.3	79.4	do	Oct. 25	198
Kentucky:							
Lexington	42.08	21.28	32.9	75.9	Apr. 18	Oct. 22	187
Louisville [1]	44.33	21.82	34.4	78.6	Apr. 10	Oct. 21	194
Louisiana:							
New Orleans [1]	57.42	31.84	54.2	82.4	Jan. 25	Dec. 16	325
Shreveport	45.68	21.50	47.0	83.2	Mar. 6	Nov. 10	249
Maryland:							
Baltimore [1]	43.18	23.55	33.8	77.2	Apr. 4	Nov. 5	215
Michigan:							
Alpena	33.20	18.96	19.1	65.9	May 13	Sept. 30	140
Detroit	32.16	18.22	24.4	72.1	Apr. 30	Oct. 14	167
Escanaba	31.51	19.62	15.4	66.0	May 11	Oct. 4	146
Grand Rapids	34.27	18.93	24.5	72.3	Apr. 28	Oct. 17	172
Lansing [1]	31.08	17.99	22.4	70.9	May 2	Oct. 8	159
Marquette	32.63	18.29	16.3	64.9	May 13	Oct. 9	149
Minnesota:							
Duluth	29.93	20.87	7.9	63.9	May 7	Oct. 4	150
Minneapolis [1]	29.31	21.53	12.7	72.3	Apr. 26	Oct. 10	167
Moorhead	24.92	18.55	3.8	68.1	May 13	Sept. 24	134

[1] State section center.

Climatic tables—Continued

Stations	Average precipitation		Average temperature		Killing frost		
	Annual	Warm season, April to September	January	July	Average date of last in spring	Average date of first in fall	Average days in frost-free season
Mississippi:	*Ins.*	*Ins.*	*°F.*	*°F.*			
Meridian	53. 20	25. 10	47. 0	80. 4	Mar. 18	Nov. 5	232
Vicksburg [1]	53. 74	25. 20	48. 2	81. 3	Mar. 4	Nov. 12	253
Missouri:							
Columbia [1]	36. 61	22. 48	29. 2	76. 9	Apr. 12	Oct. 14	185
Hannibal	34. 26	22. 46	27. 1	76. 8	Apr. 15	Oct. 18	186
Kansas City	37. 37	26. 41	28. 2	78. 1	Apr. 9	Oct. 24	198
St. Louis	37. 20	21. 23	31. 1	78. 8	Apr. 4	Oct. 28	207
St. Joseph	32. 66	22. 77	26. 7	79. 2	Apr. 11	Oct. 14	186
Springfield	44. 57	27. 46	33. 5	76. 8	Apr. 14	Oct. 21	190
Montana:							
Havre	13. 67	10. 13	12. 9	68. 3	May 16	Sept. 19	126
Helena [1]	12. 77	8. 02	20. 2	65. 7	May 9	Sept. 28	142
Kalispell	15. 21	8. 14	20. 4	64. 1	May 5	Oct. 2	150
Miles City	13. 17	9. 25	14. 5	72. 9	---do-----	---do----	150
Nebraska:							
Lincoln [1]	27. 51	21. 52	22. 8	76. 5	Apr. 19	Oct. 10	174
North Platte	18. 86	15. 10	22. 9	72. 9	May 1	Sept. 30	152
Omaha	30. 66	23. 54	21. 9	76. 7	Apr. 15	Oct. 13	181
Valentine	22. 46	17. 47	18. 9	73. 7	May 6	Oct. 1	148
Nevada:							
Reno [1]	8. 43	2. 42	32. 5	67. 5	May 13	Oct. 3	143
Winnemucca	8. 40	3. 23	28. 6	70. 6	May 16	Sept. 26	133
New England:							
Boston, Mass.[1]	43. 38	20. 67	27. 9	71. 7	Apr. 14	Oct. 24	193
Burlington, Vt	31. 56	19. 10	18. 8	70. 3	Apr. 29	Oct. 12	166
Eastport, Me	43. 27	19. 63	20. 4	60. 4	---do-----	Oct. 22	176
New Haven, Conn	47. 19	23. 93	28. 2	71. 8	Apr. 16	Oct. 24	191
Northfield, Vt	33. 84	18. 51	15. 2	65. 0	May 22	Sept. 19	120
Portland, Me	42. 51	20. 16	22. 4	68. 1	May 14	Oct. 18	157
New Jersey:							
Atlantic City	40. 82	20. 15	32. 5	72. 1	Apr. 11	Nov. 5	208
Trenton [1]	44. 43	24. 03	30. 5	74. 5	Apr. 20	Oct. 19	182
New Mexico:							
Roswell	14. 04	9. 80	39. 2	78. 9	Apr. 12	Oct. 27	198
Santa Fe [1]	14. 49	9. 72	28. 8	69. 0	Apr. 25	Oct. 18	176
New York:							
Albany	36. 38	20. 17	23. 1	72. 6	Apr. 23	Oct. 16	176
Binghamton	32. 94	18. 59	24. 1	70. 0	May 5	Oct. 6	154
Buffalo	37. 28	18. 26	24. 6	69. 8	Apr. 26	Oct. 19	176
Canton	36. 18	17. 27	16. 3	68. 9	May 8	Sept. 28	143
Ithaca [1]	34. 28	19. 42	24. 3	70. 5	May 4	Oct. 10	159
New York	44. 63	22. 40	30. 9	73. 8	Apr. 10	Nov. 6	210
Oswego	36. 18	17. 27	23. 9	70. 4	Apr. 25	Oct. 24	182
Rochester	34. 27	16. 88	24. 6	70. 7	Apr. 30	Oct. 18	171

[1] State section center.

Climatic tables—Continued

Stations	Average precipitation: Annual	Average precipitation: Warm season, April to September	Average temperature: January	Average temperature: July	Killing frost: Average date of last in spring	Killing frost: Average date of first in fall	Killing frost: Average days in frost-free season
North Carolina:	*Ins.*	*Ins.*	*°F.*	*°F.*			
Asheville	41.06	23.22	35.4	71.7	Apr. 15	Oct. 20	188
Charlotte	49.20	26.08	41.2	78.4	Mar. 28	Nov. 5	222
Raleigh [1]	49.60	28.43	41.1	78.8	Mar. 29	...do...	221
Wilmington	51.05	31.26	46.5	79.1	Mar. 23	Nov. 13	235
North Dakota:							
Bismarck [1]	17.64	13.23	7.8	69.8	May 11	Sept. 20	132
Devils Lake	20.16	15.69	.3	68.1	May 16	Sept. 19	126
Williston	15.07	11.31	6.4	68.9	May 15	Sept. 20	128
Ohio:							
Cincinnati	38.33	19.63	30.3	75.1	Apr. 14	Oct. 25	194
Cleveland	35.04	19.13	26.5	71.4	Apr. 15	Nov. 2	201
Columbus [1]	36.92	19.47	28.6	74.9	Apr. 17	Oct. 18	185
Toledo	30.62	17.23	25.8	73.2	Apr. 22	...do...	179
Oklahoma:							
Oklahoma City [1]	31.69	21.19	36.4	80.6	Mar. 31	Nov. 2	216
Oregon:							
Baker	13.20	5.46	24.9	65.6	May 8	Sept. 30	145
Portland [1]	43.24	9.98	39.4	66.7	Mar. 18	Nov. 19	246
Roseburg	34.43	7.29	41.2	67.4	Apr. 14	Nov. 12	212
Pennsylvania:							
Erie	38.55	19.54	26.3	71.0	Apr. 20	Nov. 2	196
Harrisburg	37.27	20.68	29.0	74.8	Apr. 10	Oct. 27	200
Philadelphia [1]	41.17	21.73	32.6	76.2	Apr. 7	Oct. 31	207
Pittsburgh	36.35	20.17	30.7	74.6	Apr. 21	Oct. 22	184
South Carolina:							
Charleston	52.07	31.54	49.9	81.4	Feb. 20	Dec. 10	293
Columbia [1]	46.08	26.52	46.0	80.9	Mar. 18	Nov. 18	245
Greenville	51.96	26.88	40.3	76.9	Apr. 3	Nov. 2	213
South Dakota:							
Huron [1]	21.10	16.62	11.3	71.8	May 10	Sept. 23	136
Pierre	16.63	12.66	16.0	75.3	Apr. 30	Oct. 5	158
Rapid City	18.69	14.72	22.0	71.0	May 4	Sept. 29	148
Yankton	25.43	20.06	17.3	74.2	May 1	Oct. 6	158
Tennessee:							
Chattanooga	50.68	23.19	41.2	78.4	Apr. 2	Oct. 26	207
Knoxville	49.35	23.53	38.8	77.1	...do...	Oct. 28	209
Memphis	50.34	23.30	40.9	80.7	Mar. 22	Nov. 3	226
Nashville [1]	48.49	23.73	38.6	79.1	Apr. 2	Oct. 27	208

[1] State section center.

Climatic tables—Continued

Stations	Average precipitation: Annual	Average precipitation: Warm season, April to September	Average temperature: January	Average temperature: July	Killing frost: Average date of last in spring	Killing frost: Average date of first in fall	Killing frost: Average days in frost-free season
Texas:	*Ins.*	*Ins.*	*° F.*	*° F.*			
Abilene	24.74	16.68	44.2	82.8	Mar. 21	Nov. 10	234
Amarillo	22.55	16.72	35.3	76.8	Apr. 17	Oct. 29	195
Corpus Christi	27.18	15.26	56.0	82.7	Jan. 21	Dec. 28	341
Dallas	37.97	21.32	45.1	84.0	Mar. 19	Nov. 13	239
El Paso	9.84	6.43	45.0	81.1	Mar. 14	Nov. 15	246
Fort Worth	31.62	19.31	45.4	83.6	Mar. 11	Nov. 12	246
Houston [1]	47.30	26.17	52.7	83.7	Feb. 19	Dec. 1	285
Palestine	43.02	21.39	48.2	82.2	Mar. 13	Nov. 13	245
San Antonio	26.83	16.86	52.3	83.8	Feb. 24	Nov. 28	277
Taylor	35.47	19.63	47.5	82.7	Mar. 13	Nov. 22	254
Utah:							
Modena	11.19	5.90	26.7	70.6	May 23	Sept. 26	126
Salt Lake City [1]	16.03	7.15	29.2	75.7	Apr. 20	Oct. 20	183
Virginia:							
Lynchburg	43.42	22.96	37.5	77.5	Apr. 28	Oct. 27	182
Norfolk	49.54	28.02	40.6	78.7	Mar. 25	Nov. 17	237
Richmond [1]	41.63	23.08	37.9	78.5	Apr. 7	Oct. 31	207
Wytheville	40.40	22.99	33.0	72.6	Apr. 15	Oct. 13	181
Washington:							
Seattle [1]	33.11	8.57	39.5	63.1	Mar. 17	Nov. 21	249
Spokane	16.36	5.91	27.5	69.0	Apr. 14	Oct. 13	182
Walla Walla	17.67	6.49	32.7	74.0	Mar. 30	Nov. 5	220
West Virginia:							
Elkins	47.08	26.29	30.4	70.3	May 8	Oct. 8	153
Parkersburg [1]	40.22	21.93	32.5	75.4	Apr. 16	Oct. 16	183
Wisconsin:							
Green Bay	31.12	19.29	15.7	70.0	May 5	Oct. 9	157
La Crosse	31.17	22.07	16.1	72.8	Apr. 28	Oct. 10	165
Madison	31.71	20.48	16.7	72.1	Apr. 25	Oct. 17	175
Milwaukee [1]	31.40	18.54	20.6	70.1	Apr. 28	Oct. 16	171
Wyoming:							
Cheyenne [1]	13.60	10.25	25.5	66.7	May 20	Sept. 19	122
Lander	13.92	8.89	18.3	67.4	May 19	Sept. 18	122
Sheridan	14.43	9.36	18.9	67.3	May 20	Sept. 20	123
Yellowstone Park	18.80	8.14	17.6	61.5	May 21	Sept. 16	118

[1] State section center.

16. WILD LIFE

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WILD LIFE

GENERAL

Bird Refuges and Game Preserves

Refuges are coming to be an increasingly important feature of efforts to conserve and to increase desirable forms of birds and mammals. The number of areas that serve directly or indirectly as Federal bird refuges is 110. Of these, 72 are administered by the Bureau of Biological Survey and include 5 big-game preserves, for such mammals as mountain sheep, buffalo, elk, deer, and antelope. Of the remainder, 19 are national parks, which are set aside primarily as recreation areas, but also afford protection to birds, mainly nongame birds, and to desirable species of mammals. There are also more than 800 areas, large and small, set aside by States for various purposes on which wild-animal life is directly or indirectly protected. The bird and mammal refuges administered by the Bureau of Biological Survey extend from suitable areas in the Western States, in the Mississippi Valley, along the Great Lakes, and on the South Atlantic and Gulf coasts, to the outlying Territories of Alaska, Hawaii, and Porto Rico.

REPTILES

Treatment of Snake Bites

Determine the exact location of the bite. To prevent the systemic absorption of a fatal dose of venom, a ligature *immediately* must be placed between the wound and the heart, as above the knee or elbow if the wound is below either of these joints, and above the wound if it is on the upper arm or leg. This ligature must be loosened for a short time every 30 minutes to prevent gangrenous mortification.

After arranging ligature make deep incisions with a razor blade across the fang punctures. After the blood has flowed freely, carefully wash wound with a strong antiseptic solution freshly made with crystals of potassium permanganate. Another method equally successful is to inject a strong solution of potassium permanganate into each puncture and then to make local incisions. In an emergency, punctures may be incised and crystals of potassium permanganate introduced directly into the wound. A wet dressing and gauze bandage should be kept on the wound and the punctures kept open for several days to allow drainage.

If possible, get a doctor. Local treatment should be given, such as bandaging, abdominal compression, and posture to maintain circulation. The patient should be kept awake, warm, and as quiet as possible. Under ordinary conditions, alcohol, strychnine, and caffein should be avoided except under orders of a physician. When venom has been injected into a blood vessel, the chances of recovery are greatly lessened.

Except in extraordinary cases, death does not occur within 24 hours. When time permits, in particularly grave cases, application should be made to New York Zoological Park, New York City, for tube of antivenom serum.

Campers, ranchers, foresters, and pedestrians in rattlesnake country should carry a small vial containing crystals of potassium permanganate and safety-razor blades.

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BIRDS

Harmful Wild Birds

Crow Control.—The crow is by no means an unmitigated nuisance and frequently may be engaged in activities beneficial to the farmer, but occasions arise where control measures are necessary. These occur most often about the poultry yard and sprouting cornfield, and in areas where late crops of milo and corn are exposed to the attacks of crows that have congregated in their winter roost.

Although not an infallible remedy, the use of coal tar applied to the seed has met with considerable success in protecting sprouting corn against crows. This should be used in the proportion of about a tablespoonful to half a bushel of seed grain, the grain having been previously heated by the application of warm water and then drained. Continued stirring of the grain will result in an even coating of tar. The seed may then be spread out on a dry surface or may be dried by the application of an absorbent medium, as ashes, land plaster, or powdered earth. When thoroughly dry it may be used in a planter.

Crow damage to sprouting corn also may be materially lessened by the judicious use of poisoned bait. Crows are quick to sense danger, and the killing of a few at points where damage is being done or threatened usually will put a stop to their depredations. In the conduct of poisoning operations, however, State laws and local regulations governing the distribution of poison must be carefully observed; and as there is always an element of danger connected with the distribution of poison about thickly settled regions its use should be limited and judicious.

Corn is the bait usually employed for poisoning crows, and it is prepared generally by the steeping of the grain in a strong strychnine solution. If made, however, according to the following directions it will kill more quickly and its effectiveness will last for a considerable time when the bait is exposed to weather: Put 2 tablespoonfuls of starch and 1 ounce of powdered strychnine alkaloid in 1½ pints of water and heat to boiling, stirring thoroughly after the starch begins to thicken. Pour this mixture over 20 quarts of corn and stir until every kernel is coated. The grain may then be spread out and dried.

This bait may be used to advantage in fields of ripening corn where crows have started to feed on the ears. Feeding spots are usually close to wooded areas or at points farthest from farm buildings or ordinary routes of travel. Scattering a little bait between the rows in these places will frequently give the desired results.

Because of the extreme wariness of these birds, wholesale destruction through poisoning operations is difficult. Crows do practically no feeding at the large roosts where thousands gather nightly, and consequently baits placed there are of little use. It often happens that within a radius of a mile or more of such roosts crows establish congregating places that are occupied late in the afternoon. These spots may be in fields where bait can be exposed to advantage, should damage to crops warrant

it. At one roost in Oklahoma the entire assemblage of crows was induced to move away by poisoning operations in the near-by congregating places, although only a few hundred crows were actually killed.

English-Sparrow Control.—Where English sparrows are troublesome, control measures by trapping and poisoning are effective. The best results are obtained during the winter months, when the birds are hard pressed for food. Where the use of poison is not prohibited by law, bait prepared in the following manner may be employed: One-eighth ounce of powdered strychnine alkaloid is put into three-fourths gill of hot water; 1½ teaspoonfuls of ordinary laundry starch or wheat flour that has been stirred into a little cold water is then added, heat applied, and the mixture stirred constantly until it thickens. The hot, poisoned starch is then poured over 1 quart of wheat, which is stirred until every kernel is coated. The coated wheat is then spread thinly over a flat surface to dry, after which it may be kept indefinitely in well-labeled glass or metal containers.

Sparrows should be poisoned in places where other birds and domestic animals will not be endangered. Roofs, backyards, and unused poultry runs are favorable situations. Periods of heavy snowfall are especially suited for such operations, when a little bait scattered on bare spots or about horse droppings is almost sure to be picked up.

In places where poisoning is impracticable, relief may often be had through the use of a trap of the funnel type. The essential parts of this trap are: (1) A half funnel leading into (2) an antechamber which ends in (3) a complete funnel leading into (4) a final chamber. It is made of woven-wire poultry netting of three-fourths-inch mesh and is reinforced around the open end and along the sides at the bottom by No. 8 or No. 10 wire, which is used also around the aperture for the door and around the door itself. To kill mercifully a sparrow that has been trapped, place the thumb-nail at the base of its skull and dislocate its neck by hard and quick pressure.

Blackbird Control.—Because of the nomadic habits of blackbirds and the great abundance of their natural food late in summer and early in fall, the control of blackbirds during these seasons is very difficult, and it is only under the most favorable conditions that consistent and economical results can be expected. Baits similar to those recommended for crows, in which cracked corn or milo is substituted for whole corn, may be used advantageously in stands of corn where the birds have started to feed on the ears that are in the dough stage, provided the ground beneath is free of weeds. Such baits scattered sparingly between alternate rows of corn in the damaged areas are readily picked up. A few birds killed in this way frequently serve to deter others from these feeding places. It is seldom wise to attempt to cover the entire field with bait. Where sprouting corn is being damaged this bait may be used to good effect if scattered sparingly in the damaged sections.

Magpie Control.—Occasions arise, especially about poultry yards and in cattle country, where local reduction of the magpie population is desirable. Campaigns against these birds can be conducted best during winter months, when food is scarce and the birds are more or less concentrated in flocks.

A good poisoned bait can be prepared as follows: Two pounds of beef suet is put through an ordinary grinder or sausage mill, and the shredded product, which will make about 1¼ quarts in bulk, should then have dusted over it one-eighth ounce of powdered strychnine alkaloid.

This poison should be thoroughly worked into the fat—the warmth of the hands furnishes enough heat to facilitate the operation. The bait should then be cooled and again put through the grinder. The grinder must be thoroughly cleaned afterwards with a hot soap solution to remove all trace of the strychnine.

This bait may be safely exposed in what may be termed a suet stick. This consists of a 2 by 4 inch scantling of convenient length (6 to 8 feet), into which a number of holes about 1½ inches in diameter and 1½ inches deep have been bored at intervals of 6 inches and filled with the bait, which should be compressed rather firmly. The suet stick should then be nailed or wired to a tall fence post, limb of tree, or other convenient support, where it will be out of reach of domestic animals. Beneath the stick a carrion station consisting of a portion of a carcass should be established to attract the birds. In locating such poisoning stations avoid areas in which small insectivorous birds abound. As soon as the offending birds have been killed the suet stick should be removed and buried.

Pinyon-Jay Control.—Fields of corn or wheat located near foothills that are covered with nut pine (pinyons) in the Rocky Mountain region are often subject to attack by wandering flocks of pinyon jays. Damage to corn occurs when the grain is about ripe and to wheat when it is in the shock.

Upon first entering a cornfield the jays are likely to scatter, but within a few days they are inclined to settle down to a definite section of the field where they have previously opened ears, and to return again and again to that same spot. This is the place to carry out effective poisoning operations, and until such a feeding area has been established it is useless to distribute poisoned bait.

In fields of shocked wheat pinyon jays are usually well scattered, and as the waste grain in these stubble fields is a favorite food for large numbers of mourning doves, poisoning operations there are not practicable.

The poisoned bait recommended for crows may be used against pinyon jays, but about 2 tablespoonfuls of glycerine should be added for every 20 quarts of bait to make it more resistant in periods of wet weather. The glycerine should be added to the liquid paste before it is applied to the grain.

The poisoned grain should be distributed only in those portions of cornfields where damage has started. Scatter it by taking a handful at a time and letting it run slowly through the fingers while walking at a moderate pace between the rows. One handful of shelled corn thus spread will cover about 40 linear feet in the row. Except in small fields, poison scattered in every other row is sufficient. Usually 5 to 10 quarts of poisoned grain will cover the damaged section. These baits should not be placed in fields to which turkeys, ducks, geese, and young chickens have access. Chickens possess a marked immunity to strychnine poisoning, but the other birds mentioned are susceptible and must be kept out of baited fields. When the bait is scattered as directed there is no danger to stock that subsequently may be pastured in the field.

Bird Roosts.—At certain seasons, such birds as grackles (blackbirds), starlings, cowbirds, English sparrows, purple martins, and robins establish nightly roosts at which thousands often gather. Frequently these roosts are in the residential sections of cities, where their noise and filth become a decided nuisance. To remove such roosts

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the following methods are recommended: When the roost is populated with birds not protected by Federal or State laws (usually true of grackles, cowbirds, and starlings) and when local regulations do not forbid, the use of shotguns is the most effective in bringing relief. Shells carrying No. 6 or No. 8 shot and loaded with black powder in order to make a loud report will give the best results. Firing may be done even in thickly settled sections if directed upward toward the tree tops.

In large roosts, where the bird population may be as great as 30,000, the work of four or five men will be required. *Above all, shooting should begin when the first birds appear early in the evening,* as then they may be easily frightened. Later on, when darkness arrives, the use of guns avails but little, as the birds will then move only a few yards at a time. Shooting should be kept up on successive evenings until the birds move on. Persistence is the secret of success, and in large roosts it may take five or six evenings to accomplish the desired results.

When such protected species as robins and martins are concerned, or when roosts are formed in localities where the use of firearms is prohibited, Roman candles will sometimes give the desired results.

Game Birds

Propagation of Game Birds.—The possibility of replenishing depleted game coverts with birds raised in captivity has been demonstrated both in this country and in Europe. Methods of rearing pheasants and quail in particular have become standardized, but the demand exceeds the supply for restocking and breeding purposes.

Most States have laws or regulations affecting the propagation of game birds, and many require game breeders to take out licenses. In addition Federal permits are necessary to possess migratory game birds in captivity. These permits are obtainable through the Bureau of Biological Survey, United States Department of Agriculture.

To be successful the propagation of game birds must be on a crop basis. On the efficient and economical game farm as much as possible of the feed consumed by the birds must be produced on the ground. There also should be sufficient area to permit the practice of the ordinary principles of crop rotation, and to afford ample space for the ranging of the birds on new or rejuvenated ground.

Predatory birds must be guarded against on the game farm. Appropriate fencing, of a temporary, semitemporary, or permanent character, is the main reliance against predatory mammals. Much also can be done with cage traps set about the border of the game reservation.

Marked success has been had with the ring-necked pheasant. The bird is polygamous, prolific, and hardy, and although sufficiently controllable to be suited to captivity, it retains its wariness so that it can take care of itself when released. It thrives even in the northernmost States. Incubation of the eggs on most farms is by domestic hens, incubators being used only in emergencies. When hatched the young, with their foster mother, are removed to the rearing field, where for a time the hen is confined in a coop and the young allowed to have a limited range. This range is increased as they grow older until, after wing clipping, they are given free range in carefully fenced fields.

The equipment and system used in quail propagation are similar in a general way to those employed in pheasant raising. Differences are chiefly those necessitated by the smaller size of the birds and their nonpolygamous nature.

MAMMALS

Harmful Wild Mammals

Ground-Mole Control.—The usual method of controlling moles is by the use of traps, specially designed. These are set in such way that the trap will be sprung by the lifting of the trigger as the animal pushes along through its runway. Most of the traps are so constructed that the moles will be impaled by points driven into the soil or will be caught in the projecting jaws or loops extending down alongside or under the runway. Lawns and similar places often may be cleared of moles if about 1 teaspoonful of concentrated lye is placed in their runways through openings made at intervals of about 25 feet. After the lye is put in place the holes should be carefully closed with sod or other material in such way that the lye will not be covered up.

Predatory-Mammal Control.—Where predatory animals are proving troublesome through destruction of livestock, game, poultry, or otherwise, they may usually be disposed of by the use of traps and poison. Steel traps of suitable size and design are generally preferred. For such small animals as weasels, minks, and skunks, No. 1 or No. 2 traps are satisfactory; for animals of the size of the fox or coyote, a No. 3 trap may be used; and for those of the size of the timber wolf, No. 4 traps are usually chosen. Traps are usually fastened securely by the chain to wooden or iron stakes, or the chain is equipped with drag hooks. They are usually set along trails, runways, or other places known to be frequented by the animals sought. The most successful sets are those where the trap is concealed with a light coat of dirt, care being taken to cover or to support the pan so that its action will not be interfered with and to see that nothing is in the way to prevent prompt action of the spring and jaws of the trap. After the trap set has been completed the ground should be brushed over lightly with twigs or leaves so that it will have a natural, undisturbed appearance. Care must be exercised not to leave any sign or materials which will arouse the suspicion of the animals and cause them to avoid the place. Baits made of various small animals that occur in the locality or other foods attractive to the animals are often employed, but scent baits usually are preferable. A scent bait attractive to many predatory animals may be prepared as follows:

Any kind of fish may be used, but such oily varieties as sturgeon, eel, trout, sucker, and carp are preferred. The flesh should be ground in a sausage mill, placed in strong tin or iron cans, and left in a warm place to decompose thoroughly. Each can must be provided with a small vent to allow the escape of gas; otherwise there is danger of explosion, but the aperture must be screened with a fold of cloth to prevent flies depositing eggs.

This scent may be used within three days after it is prepared, but it is more lasting and penetrating after a lapse of 30 days.

Fish scent alone has been used with excellent results, but several modifications are also recommended. Using the decomposed fish as a basis, mice, beaver castors, musk glands from minks, weasels, and muskrats, and the bladders of coyotes and bobcats may be added. Oil gives body to the scent and to a certain extent prevents freez-

ing in zero weather. If the mixture appears too thin, glycerine, brains, fish oil, butterfat, or such other animal oils as fat from woodchucks and ground squirrels may be added.

An excellent system for a hunter to follow is to commence with a quantity of ground fish placed in a large iron container similar to a milk can. As the original lot is used on the trap line, it should be replenished by addition of more fresh fish and others of the ingredients mentioned. The addition from time to time of new material seems to improve the quality of the scent mixture.

Poisoning.—Strychnine is generally used in poisoning predatory mammals. It may be used in capsules, in the form of tablets, or in the granular or paste forms prepared by the Bureau of Biological Survey. About 3 grains of strychnine may be used for such large animals as timber wolves, and about 1½ grains for coyotes, the quantity being correspondingly smaller for smaller animals. The poison is used in small baits of fat. Fresh pork fat, beef suet, and fat from horses and sheep make attractive baits. These may be ground and molded into small pellets or cut in small chunks so that they may be swallowed without being chewed. Place the poison in the bait either by making a pit in the side or by splitting open, sandwich fashion. After the poison is put in place the opening should be closed securely with scrapings of fat. These baits should be carefully distributed about poison stations consisting of animal carcasses or at other places known to be visited by the animals sought. Special trails may be established if a chunk of a carcass, a piece of fresh meat, an old hide, or a similar substance is dragged along on the ground and the baits dropped along the trail thus made. Placing poison in large carcasses is not recommended. The utmost care must be exercised in distributing these poisoned baits in order to avoid the unintentional destruction of dogs or other domesticated animals or of valuable fur bearers.

CAUTION REGARDING POISONS.—All poison containers and all utensils used in the preparation of poison should be kept *plainly labeled* and *out of reach* of children, irresponsible persons, and livestock until thoroughly cleaned.

Rodent Control

Prairie-Dog Control.—Prairie dogs are most readily controlled by poisoning and fumigation. For poisoning, dissolve 1 heaping tablespoonful of dry gloss starch in a little cold water and add to three-fourths pint of hot water. Boil, stirring constantly, until a thin, clear paste is formed. Mix together 1 ounce of powdered strychnine alkaloid and 1 ounce of baking soda, sift into the hot starch paste, and stir thoroughly to a smooth creamy mass. Add one-fourth pint of corn sirup, 1 tablespoonful of glycerine, and one-tenth of an ounce of saccharine and stir thoroughly. Pour this mixture over 13 quarts of oats and mix until each grain is evenly coated. It is important that only the best grade of clean oats be used, as chaff absorbs and wastes much valuable strychnine, and poisoned weed seeds imperil useful bird life. Milo and kafir may be used instead of oats where these are available and the animals show preference for them.

Each quart of the prepared grain is sufficient to treat about 40 prairie-dog burrows. About one tablespoonful should be scattered sparingly on clean, hard ground near each hole. Do not place the poison on loose or dusty ground or in the holes. With reasonable care in scattering the bait, livestock on the open range will not be endangered. The poison is effective at any time that prairie dogs are active.

Carbon disulphide may be used in the fumigation of burrows. One ounce (2 tablespoonfuls) of this material should be poured on a small piece of cotton waste, shoddy wool, or other cheap absorbent material, and placed well down in the burrow. The mouth of the burrow should be closed immediately with a shovelful of earth or sod so that all occupants of the burrow may be asphyxiated. Every burrow that shows evidence of being used should be treated, and all holes should be closed with dirt. One gallon of carbon disulphide is sufficient to treat from 100 to 130 holes. This can be accomplished by one man in two or three hours.

Less gas is absorbed by damp soil, hence carbon disulphide is somewhat more effective after heavy rains. Careful and judicious use of this liquid should exterminate practically all the prairie dogs from the area treated.

CAUTION.—Carbon disulphide evaporates rapidly, so should be kept in tightly corked bottles or cans. It is highly *explosive* and *inflammable* and should never be brought near fire.

Ground-Squirrel Control.—Most of the ground squirrels can be controlled by the use of the poison and fumigation methods given for prairie dogs. The principal modification is in the quantity of grain used. The grain required per ounce of strychnine varies from 8 or 10 quarts for the black ground squirrel of Montana and Wyoming to 20 quarts for such species as the Richardson ground squirrel.

For poisoning Columbian ground squirrels and other species that hull the grain very skillfully in eating, 8 tablespoonfuls of flour added to a little cold water and stirred thoroughly to make a creamy paste may be used in place of the starch paste.

For fumigating a ground-squirrel burrow two-thirds ounce (1½ tablespoonfuls) of carbon disulphide is sufficient. This requires about 1 gallon to every 200 holes. Crude calcium cyanide is effective for fumigating burrows of the Columbian ground squirrel. It is used in the form of dust and flakes. An ounce of the dust may be blown into the ground-squirrel burrow by the use of a portable blower. An ounce of the flakes may be placed down in the mouth of the burrow by the use of a long-handled spoon. With the latter it is not necessary to close the holes.

Pocket-Gopher Control.—Pocket gophers are readily caught in any one of several makes of special traps commonly on the market, and a few of these set in the entrance of burrows suffice to keep small areas free of the pests. For ridding alfalfa fields, orchards, and long stretches of levees or irrigation-ditch embankments of the rodents, a successful and much more practical method is to poison them by use of baits of sweet potato, carrots, parsnips, clover, or alfalfa placed in their underground runways.

The vegetable baits should be cut about 1 inch long and one-half inch square. From a pepperbox slowly sift one-eighth ounce of powdered strychnine alkaloid, mixed with an equal quantity of baking soda, over 3 quarts of the freshly cut baits, stirring to distribute the poison evenly.

Good results may often be obtained by the use of oats poisoned as for prairie dogs, a tablespoonful being placed in the pocket-gopher runway in the same way as the vegetable baits. One ounce of powdered strychnine alkaloid dusted over 10 pounds of fresh green clover or alfalfa leaves is effective against some species, if a quantity equal to two or three dozen leaves is used for each bait.

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The runways, which usually are 4 to 8 inches beneath the surface, can be located by means of a probe made of any strong handle, 1 inch in diameter and 30 inches long, with one end bluntly pointed. Into the other should be fitted a piece of one-fourth-inch iron rod, protruding about 15 inches and bluntly pointed. A foot rest aids in the probing of hard soils. If the iron rod is forced down near pocket-gopher workings or a foot or two back of fresh mounds, the open tunnel can be felt as the point breaks into it. The blunt end of the instrument is then used carefully to enlarge the hole, the bait is dropped into the main runway, not in the laterals, and the probe hole closed. A shovel or trowel may be used to open the runway, but care must be exercised not to disturb the runway unduly or to cover up the bait when closing the hole.

One soon becomes expert in locating the runs and can treat 300 to 500 pocket-gopher workings in a day. Baits need be placed at only two points in each separate system of 10 to 30 mounds, which is usually the home of a single animal. Experience has shown that baits placed fairly in the open runs usually kill the pocket gophers. Some trapping may be required to kill animals that refuse to eat the poison.

Rabbit Control.—Cottontails and jack rabbits are usually controlled by shooting, trapping, poisoning, or drives. The traps most commonly employed for cottontails are the old-fashioned box traps set with a "figure-4" trigger with cord attached to hold up the box lid. A number of special modifications of this trap have been made, and a considerable variety of other traps have been designed for this purpose.

Where jack rabbits are feeding about hay or grain stacks, they may often be trapped by a woven-wire fence erected about the stack, with funnel-shaped or wedge-shaped openings at intervals and the loose ends of the wire projecting into the inclosure. The openings should be so made that the rabbits can push through them but can not come out. Wire netting may be put around the base of the stack inside the fence if it is desired to prevent the trapped animals from feeding on the hay or grain during the interval they are in the trap.

The following poison preparations have proved effective where rabbits are feeding or are congregated:

Poisoned alfalfa leaves.—Dissolve 1 ounce of strychnine sulphate in 2 gallons of hot water, and sprinkle over 10 pounds of alfalfa-hay leaves. Mix the leaves thoroughly until all moisture is absorbed. The poisoned leaves should be distributed in small handfuls in lines a few feet apart across portions of fields where observations made at night show the rabbits to be feeding.

Poisoned alfalfa should be distributed *only* in places from which livestock is excluded. Such places should be baited with a small quantity of clean alfalfa hay a few nights previous to poisoning in order to get the rabbits accustomed to feeding there. In localities where alfalfa is not raised, rye, wheat, barley, or emmer heads, or sheaves of the grain may be substituted.

Caution.—Great care must be exercised in using these baits, as they are likely to be eaten by livestock.

Poisoned oats.—Mix 1 tablespoonful of starch in one-half cup of cold water, and stir into 1 pint of boiling water to make a thin, clear paste. Mix 1 ounce of powdered strychnine with 1 ounce of powdered bicarbonate of soda (baking soda), and stir with the starch to a smooth, creamy mass. Stir in 1 teacupful of table salt. Apply to 12 quarts of good, clean oats, and mix thoroughly to coat each kernel.

Distribute as in directions for use of poisoned alfalfa leaves, using a large tablespoonful at each place. Each quart should make 25 to 30 doses. A clear, cold night, when snow is on the ground and the rabbits' natural food supply is scarce, is the best time to expose this poison.

Poisoned salt.—When rabbits are feeding on succulent green crops, such as growing grain or alfalfa, there is considerable craving for salt, and good results may be obtained by the use of a mixture in the proportion of 1 ounce of strychnine alkaloid to 16 ounces of fine salt. Teaspoonful baits may be placed on clean, hard surfaces, in jar lids spiked to the ground, or in pieces of 2 by 4 inch scantling, in which 1-inch auger holes have been bored. Care should be exercised in the use of poisoned salt to prevent domestic animals from having access to it.

Rabbits may also be poisoned by crystals of strychnine inserted in pieces of apple or melon rind and placed at intervals along their runs or paths.

Protective devices.—Where rabbits are abundant and the area to be protected is not too great, a rabbit-proof fence may be made of a netting of galvanized wire with 1½-inch mesh and 2½ to 3 feet high. Trees may also be protected from rabbits by the use of mechanical contrivances or protective washes. Poultry netting of 1-inch mesh and 18 inches wide is used for cottontails. The wire is cut in about 1-foot lengths, rolled into cylindrical shape about the trunk of the trees, and the projecting ends of the wire bent to fasten it. Veneer and other wooden protectors, heavy building paper, and gunny sack or other cloth wrappings may be used to make a sheath about the base of the tree of sufficient height to prevent rabbits from gnawing the bark. For jack rabbits and in regions of heavy snowfall a height greater than 18 inches is required.

Protective washes are often dangerous to young trees, and many of them are not sufficiently permanent to afford protection for an entire winter. One of the most satisfactory mixtures consists of 1 part of creosote oil to 2 or 3 parts of coal tar. This may be applied with a brush to the trunk of the tree. It is injurious to the soft bark of seedlings up to about 2 years of age and may also injure larger trees if it is allowed to extend below the ground surface.

Undiluted lime-sulphur solution is useful, but it is effective only a short time and must be renewed several times during an average winter. Addition of a pound of glue to a gallon of the concentrated lime-sulphur adds somewhat to its durability.

Rabbit drives.—Rabbit drives are better adapted to control jack rabbits than cottontails, and are necessarily community affairs. Select in each community an infested area of not more than two sections, and in it build a corral. The location of the corral should be close to a natural cover, such as brush and rank growths of weeds and grass, as rabbits will enter it more readily there than if it is placed in the open. The corral should be 50 feet in diameter, with wings extending at least a quarter of a mile from each side of the entrance.

Both corral and wings should be constructed of 1 or 2 inch mesh wire netting, 36 inches wide. The netting may be held in an upright position by seven-sixteenths inch iron rods 4 feet long, 1 foot of which is driven into the ground. Stock fences and natural barriers should be used where possible in order to reduce the cost of construction. They are more convenient and practical for local community drives.

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After corral and wings are erected, the next step is to organize the line of beaters. The line of drive should present a semicircle with the extreme ends of the lines a quarter of a mile from the end of the respective wings and upon the extended line of the wings. Each beater should carry a stout club about 30 inches long, for driving and killing rabbits. The beaters should be in squads of five each, the center member of each squad to be the leader. Each leader will at all times direct the movement of his squad in close cooperation with other leaders, all under the direction of a marshal, maintaining interval and alignment, and concentrating the movement on the corral.

The movement of the line should be slow and steady. At the start of the drive the interval between beaters should be not less than 20 nor more than 35 feet. The alignment and an orderly interval must be maintained at all times. The line of beaters must first be established, and when all are in their respective places they should move forward at a signal given by the marshal. Do not crowd the rabbits. Allow some to drift into the corral and the others will follow.

Control of Mice (Field and Orchard).—In orchards mechanical devices made of fine-meshed wire netting, wooden veneer, or such other wrappings and washes as are described under "Rabbit Control" are often employed for protection against field mice. When in small numbers these rodents may be caught readily in strong mousetraps of the usual snap or guillotine type by the use of oatmeal or other grain as bait. Where mice occur in considerable numbers, destroying them by the use of poison is the more practicable procedure. The placing of poisoned baits in an orchard should be made a regular part of its care, especially in autumn. Poisoned grain should be distributed in shelters so made of wood, glass, tile, or metal as to protect the grain from storms and moisture but to permit mice to enter and to feed readily.

Mix together, dry, one-eighth ounce of powdered strychnine alkaloid and one-eighth ounce of baking soda, and sift the mixture over 1 quart of rolled oats, stirring constantly to insure an even distribution of the poison through the grain. Thoroughly warm the poisoned rolled oats in an oven and sprinkle over them 6 tablespoonfuls of a mixture of 3 parts of melted beef fat and 1 part of melted paraffin, mixing until the oats are evenly coated. When the grain is cool it is ready for use.

For larger quantities, use in the proportion 1 ounce of strychnine, 1 ounce of soda, 8 quarts of rolled oats, and 1¼ pints of beef-fat and paraffin mixture. Teaspoonful quantities of the poisoned rolled oats should be placed in the small containers or stations and distributed near the bases of trees to be protected, or over the infested area. Teaspoonful quantities may also be scattered along runways and within the entrances of the burrows. The starch-strychnine paste described under "Prairie-dog control" may also be used to advantage if applied to 12 quarts of wheat or to 20 quarts of steam-crushed whole oats and mixed thoroughly so that each kernel is coated.

An effective vegetable bait may be prepared as follows: Cut 3 quarts of sweet potatoes into one-half-inch cubes. Mix one-eighth ounce of powdered strychnine and one-eighth ounce of baking soda and, using a pepperbox, sift this over the freshly cut sweet potatoes, stirring the mixture constantly to distribute the poison evenly. Use the bait while it is fresh by dropping one or two pieces into mouse tunnels through natural or artificial openings. These baits may also be scattered at the bases of trees or in other places frequented by mice.

Control of Woodchucks (Marmots or Ground Hogs).—In the Eastern States woodchucks, or ground hogs, may be destroyed most readily if their burrows are fumigated with carbon disulphide or crude calcium cyanide. About 1½ ounces (3 tablespoonfuls) of carbon disulphide should be poured on a piece of cotton or other absorbent material and placed as far down in the burrow as possible, after which the entrance should be tightly closed with sod or damp earth. One tablespoonful of calcium cyanide flakes is sufficient to treat one burrow. Place this quantity well down into the mouth of the burrow, after which it can be either closed or left open. Either procedure is effective, but an occasional animal may escape the first fumigation and, if the holes are closed when treated, those reopened will indicate at once the holes that should be re-treated.

In many sections of the West fumigation is not practicable because of the character of the places in which woodchucks live. In such places the animals may be controlled most readily by the use of poison prepared and distributed in the following way:

Poisoned grain.—Mix 1 tablespoonful of gloss starch in one-half teacupful of cold water and then stir this into one-half pint of boiling water to make a thin, clear paste. Mix 1 ounce of powdered strychnine alkaloid with 1 ounce of baking soda and stir with the starch into a creamy mass, beating it until it is free of lumps. Add to this one-fourth pint of heavy corn sirup, 1 tablespoonful of glycerin, and 1 teaspoonful of saccharine dissolved in a little warm water. Beat the starch mass again, and then pour it over 12 quarts of oats in a tub or tight box and mix thoroughly or until there are no dry kernels. Four tablespoonfuls of salt added to the boiling water before the starch is put in increases the effectiveness of the poison during the crop-growing season. Only good, heavy recleaned oats should be used for this bait.

In distributing the poisoned grain place a handful in a place on a clean hard surface close to the den or burrow. Woodchucks pay no attention to scattered grain.

Poisoned green alfalfa.—A satisfactory bait can be made by the use of green alfalfa. Mix dry 1 ounce of powdered strychnine alkaloid with one-eighth ounce of powdered saccharine and place in a pepperbox, properly labeled. Dust this mixture over about 20 pounds of freshly cut alfalfa tops that have been moistened with a solution made of 2 parts corn sirup and 1 part water. Place the baits (a handful to a place) near burrows, trails, and lookout points.

Poisoned salt.—Mix 1 ounce of strychnine alkaloid with 12 ounces of table salt. Place salt on clean hard surfaces, a teaspoonful to a bait, or in jar lids spiked to the ground. The bait is best exposed in the fields where ground hogs are feeding.

CAUTION.—Care must be taken to place these baits out of reach of stock.

Control of House Rats and Mice.—The animals commonly known as house rats and mice occur in a wide variety of places about city and rural structures, where they cause great annoyance and loss and are a constant menace to the health of man and of domestic animals. Means for their control consist of the use of traps, poisons, fumigants, deterrents, and the construction or repair of buildings to exclude them. Many effective traps are on the market, but those commonly known as "snap" or "guillotine" traps have proved most generally adapted for use against rats and mice.

Traps should be baited with attractive food, such as bread, fried bacon, raw or cooked meats, fish, nut meats,

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cheese, apples, or carrots. Sprinkling rolled oats over and about the trap adds to its effectiveness. Traps should be set along runways and at points where the animals will seek concealment and in such a way that they are likely to run over the trigger of the trap even when not attracted by the bait. Many artifices in concealing traps may be adopted, and intelligence and persistence are required to outwit these animals. Be sure to use sufficient traps.

Where it is practicable to employ poisons the use of barium carbonate in the following way is recommended: Select a bait from each of the following three classes and mix powdered barium carbonate with it in the proportion of 1 part (by weight) of poison to 4 parts of bait (adding water when necessary to make baits moist): (1) Meat—Hamburg steak, sausage, canned salmon, and sardines; (2) fruits or vegetables—apple, tomato, melon, etc.; (3) cereals—bread, rolled oats, and the like.

Wrap teaspoonful quantities of the three kinds of poisoned baits separately in small paper bags or in small squares of newspaper and put one of each kind in places where rats are apt to feed. Remove uneaten baits each morning and put out fresh ones in the evening. Continue this until all rats are gone. Other foods should be removed or made inaccessible to rats before poisoned baits are distributed.

Where rats occur in burrows, as around garbage dumps and similar places where fumigation is practicable, they may be destroyed in large numbers by the use of carbon disulphide or crude calcium cyanide applied as in woodchuck burrows, or the calcium cyanide dust may be forced into burrows by means of a portable dust blower.

A ready method of destroying rats in burrows is to direct the exhaust gas from an automobile or other gas engine into their burrows by means of a hose. The opening should be filled in around the hose with moist earth and the engine operated at moderate speed for 10 minutes or more.

In seed houses or other places where the odor will not prove objectionable, the use of flake naphthalene scattered about liberally has a tendency to prevent infestation with rats and mice.

Among the most important measures in obtaining relief from these animals is the employment of means to exclude them from buildings and from food or other supplies likely to be damaged by them. Fine-meshed wire netting may often be used to encase storage places. By means of tight-fitting doors and the use of cement, metal strips, and wire netting at points where these animals may gnaw through or otherwise gain access to buildings, their entrance can be prevented at moderate cost.

Fur-Bearing Mammals

Production and maintenance of a constant supply of fur plays an important part in the economic program of our country. There are about 2,500 fur farmers in the United States and Alaska, with a total investment between $18,000,000 and $20,000,000. The industry, conservatively developed, should become a permanent addition to our agricultural production. The land used for this purpose is usually of little value for crop growing, and this industry affords means of utilizing it.

The objects of the department's work on fur resources are (1) to direct attention to the great commercial importance of fur, (2) to emphasize the need of maintaining the supply of fur animals, and (3) to point out methods by which this supply can be maintained not only as to quantity but improved as to quality. Information re-

garding fur bearers is assembled in the form of letters, articles, and bulletins, and is distributed free of charge to those who request it. The data obtained in this work form a background for furnishing necessary information in the formulation of uniform trapping laws and in assisting the fur trade.

The United States Department of Agriculture maintains an experimental fur farm at Saratoga Springs, N. Y. Fur-bearing animals in captivity are studied to determine economical methods of raising them; to ascertain conditions under which the various species can be raised profitably and produce good fur; to develop, by selective breeding, improved strains of promising species; to determine the breeding, gestation, whelping, and prime fur periods; and to investigate diseases and parasites for the purpose of determining methods of prevention and treatment. The experimental fur farm is open to the general public from 10 a. m. to 4 p. m. on Wednesdays and Sundays from June 1 to December 1.

With the disappearance of many wild fur-bearing animals the use of rabbit skins in the manufacture of fur coats and as trimming for other garments is steadily increasing. More than 100,000,000 skins, valued at approximately $25,000,000, are used annually. Domestic rabbit raising in the United States is a growing commercial industry with an established market for both meat and fur. The Bureau of Biological Survey is conducting experiments in breeding, housing, feeding, and other phases of rabbit raising for the purpose of determining the more successful management practices, and of cooperating with breeders and organizations in the marketing of the meat and fur.

Alaska Reindeer

The production of reindeer, although a promising industry in Alaska, is not suited to conditions in any part of the United States. Reindeer grazing is limited to the arctic and subarctic regions.

The Bureau of Biological Survey is making detailed investigations regarding the food resources of Alaska suited to these animals; also of the management practices that are most successful, and of the diseases and parasites of reindeer.

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REGULATORY WORK

Lacey Act, Regulating Interstate Commerce in Game

The Lacey Act, passed May 25, 1900, as amended and included in sections 241 to 244, United States Criminal Code (March 4, 1909), makes it unlawful to deliver to a common carrier for transportation from one State, Territory, or District to another the dead bodies or parts thereof of any wild animals killed or shipped in violation of the law of the State, Territory, or District in which killed or from which shipped. All packages containing the dead bodies of wild animals, or parts thereof, when shipped in interstate or foreign commerce, are required to be clearly marked so that the name and address of the shipper and the nature of the contents may be ascertained on an inspection of the outside of such package. The shipper, the common carrier, and the consignee knowingly receiving illegal shipments, are each liable to a penalty of $200 for violation of the act.

Section 242 of the Criminal Code, so far as it relates to interstate transportation of wild birds, or parts thereof, has been superseded by section 4 of the migratory-bird treaty act.

The act also prohibits the importation of the mongoose, "flying foxes" or fruit bats, the English sparrow, the starling, and such other birds and animals as the Secretary of Agriculture may from time to time declare to be injurious to agriculture or to horticulture.

Importation of Wild Mammals and Birds.—A permit is required from the Secretary of Agriculture to imoprt live wild animals and birds from foreign countries. The permits are issued free of charge, but do not exempt such importations from the duties and other provisions of the tariff act. Application forms may be obtained from the chief of the Bureau of Biological Survey.

Migratory-Bird Treaty Act

Under the act approved July 3, 1918, giving effect to the migratory-bird treaty concluded August 16, 1916, for the protection of birds migrating between the United States and Canada, it is unlawful to hunt, take, capture, kill, possess, sell, purchase, ship, or transport at any time or by any means any migratory bird included in the terms of the treaty, except as permitted by regulations which the Secretary of Agriculture is authorized and directed to adopt, and which become effective when approved by the President. The act provides police and other powers necessary for its effective enforcement. The constitutionality of the treaty and the act has been sustained by the United States Supreme Court.

Migratory Birds Protected—1. *Migratory game birds.*—

(*a*) Anatidae, or waterfowl, including brant, wild ducks, geese, and swans.

(*b*) Gruidae, or cranes, including little brown, sandhill, and whooping cranes.

(*c*) Rallidae, or rails, including coots, gallinules, and sora and other rails.

(*d*) Limicolae, or shorebirds, including avocets, curlews, dowitchers, godwits, knots, oyster catchers,

phalaropes, plovers, sandpipers, snipe, stilts, surf birds, turnstones, willet, woodcock, and yellowlegs.

(*e*) Columbidae, or pigeons, including doves and wild pigeons.

2. *Migratory insectivorous birds.*—Cuckoos; flickers and other woodpeckers; nighthawks (bull-bats) and whip-poor-wills; swifts; hummingbirds; flycatchers; bobolinks, meadowlarks, and orioles; grosbeaks; tanagers; martins and other swallows; waxwings; shrikes; vireos; warblers; pipits; catbirds and brown thrashers; wrens; brown creepers; nuthatches; chickadees and titmice; kinglets and gnat catchers; robins and other thrushes; and all other perching birds which feed entirely or chiefly on insects.

3. *Other migratory nongame birds.*—Auks, auklets, bitterns, fulmars, gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, and terns.

Application of Federal Regulations to State Laws.—In the interpretation of the Federal regulations it should be borne in mind that nothing therein is to be construed to permit the taking, possession, sale, purchase, or transportation of migratory birds, or their nests or eggs, contrary to the laws and regulations of any State, Territory, or District, made for the purpose of *giving further protection* to migratory birds, their nests and eggs, when such laws and regulations are not inconsistent with the migratory-bird treaty act, and do not extend the open seasons for such birds beyond the dates prescribed by the Federal regulations.

Means by Which Migratory Game Birds May Be Taken.—Migratory game birds on which there is a prescribed open season under the migratory-bird treaty act regulations may be taken during such open season with a gun only, not larger than No. 10 gauge, fired from the shoulder, and may be taken during the open season from the land and water, with the aid of a dog, the use of decoys, and from a blind or floating device (other than an airplane, power boat, sailboat, any boat under sail, or any floating device towed by power boat or sailboat).

Open Seasons on and Possession of Certain Migratory Game Birds.—The regulations under the migratory-bird treaty act are subject to change. Write to the Bureau of Biological Survey, United States Department of Agriculture, Washington, D. C., for latest revision (April 22, 1926). Each period of time herein prescribed as an open season is to be construed to include the first and last days thereof.

Waterfowl (except wood duck, eider ducks, and swans), rails, coot, gallinules, greater and lesser yellowlegs, woodcock, Wilson snipe or jacksnipe, and mourning doves may be taken each day from half an hour before sunrise to sunset during the open seasons prescribed therefor in this regulation by the means and in the numbers permitted, and when so taken may be possessed any day in any State, Territory, or District during the period constituting the open season where killed and for an additional period of 10 days next succeeding said open season, but no such birds shall be possessed in a State, Territory, or District at a time when such State, Territory, or District prohibits the possession thereof.

Waterfowl (except wood duck, eider ducks, and swans), coot, gallinules, and Wilson snipe or jacksnipe.—The open seasons for waterfowl (except wood duck, eider ducks, and swans), coot, gallinules, and Wilson snipe or jacksnipe shall be as follows:

In Maine, New Hampshire, Vermont, Massachusetts (except in Nantucket and Dukes Counties), Ohio, West Virginia, Michigan, Wisconsin, Minnesota, Iowa, Missouri,

North Dakota, South Dakota, Nebraska, Kansas, Colorado, Wyoming, Montana, and Nevada the open season shall be from September 16 to December 31;

In New York (except Long Island) the open season shall be from September 24 to January 7;

In that portion of Massachusetts known as Nantucket and Dukes Counties, and in Rhode Island, Connecticut, Pennsylvania, Illinois, Indiana, Oklahoma, Utah, Idaho, Oregon, and Washington the open season shall be from October 1 to January 15;

In that portion of New York known as Long Island, and in New Jersey, Delaware, California, New Mexico, Arizona, and that portion of Texas lying west and north of the main tracks of the International & Great Northern Railroad extending from Laredo to San Antonio, Austin, and Longview, and the Texas & Pacific Railroad extending from Longview to Marshall and Texarkana the open season shall be from October 16 to January 31;

In Maryland, the District of Columbia, Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Arkansas, Louisiana, and that portion of Texas lying east and south of the main tracks of the International & Great Northern Railroad extending from Laredo to San Antonio, Austin, and Longview, and the Texas & Pacific Railroad extending from Longview to Marshall and Texarkana the open season shall be from November 1 to January 31; and

In Alaska the open season shall be from September 1 to December 15.

Rails (except coot and gallinules).—The open season for sora and other rails (except coot and gallinules) shall be from September 1 to November 30, except as follows:

In Louisiana the open season shall be from November 1 to January 31.

Greater and lesser yellowlegs.—The open seasons for greater and lesser yellowlegs shall be as follows:

In Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, and Virginia the open season shall be from August 16 to November 30;

In the District of Columbia, North Carolina, South Carolina, Tennessee, Arkansas, Oklahoma, Texas, New Mexico, Arizona, California, and Alaska the open season shall be from September 1 to December 15;

In Vermont, Pennsylvania, Ohio, West Virginia, Kentucky, Indiana, Michigan, Wisconsin, Illinois, Missouri, Iowa, Minnesota, North Dakota, South Dakota, Nebraska, Kansas, Colorado, Wyoming, Montana, Nevada, and that portion of Washington lying east of the summit of the Cascade Mountains the open season shall be from September 16 to December 31;

In Utah, Oregon, Idaho, and in that portion of Washington lying west of the summit of the Cascade Mountains the open season shall be from October 1 to January 15; and

In Georgia, Florida, Alabama, Mississippi, and Louisiana the open season shall be from November 1 to January 31.

Woodcock.—The open seasons for woodcock shall be as follows:

In Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Ohio, West Virginia, Kentucky, Indiana, Michigan, Wisconsin, Illinois, Missouri, Iowa, Minnesota, North

Dakota, South Dakota, Nebraska, and Kansas the open season shall be from October 1 to November 30; and

In Delaware, Maryland, the District of Columbia, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Arkansas, Louisiana, Texas, and Oklahoma the open season shall be from November 1 to December 31.

Doves.—The open seasons for mourning doves shall be as follows:

In Delaware, Maryland, Virginia, North Carolina, Tennessee, Kentucky, Ohio, Indiana, Illinois, Minnesota, Nebraska, Kansas, Missouri, Arkansas, Oklahoma, that portion of Texas lying west and north of the main tracks of the International & Great Northern Railroad extending from Laredo to San Antonio, Austin, and Longview, and the Texas & Pacific Railroad extending from Longview to Marshall and Texarkana, New Mexico, Colorado, Utah, Arizona, California, Nevada, Idaho, and Oregon the open season shall be from September 1 to December 15;

In South Carolina, Georgia, Florida, Alabama, and Mississippi the open season shall be from October 16 to January 31;

In that portion of Texas lying east and south of the main tracks of the International & Great Northern Railroad extending from Laredo to San Antonio, Austin, and Longview, and the Texas & Pacific Railroad extending from Longview to Marshall and Texarkana the open season shall be from November 1 to December 31; and

In Louisiana the open season shall be from November 1 to January 31.

Shipment, Transportation, and Possession.—Waterfowl (except wood duck, eider ducks, and swans), rails, coot, gallinules, greater and lesser yellowlegs, woodcock, Wilson snipe or jacksnipe, and mourning doves and parts thereof legally taken may be transported in or out of the State where taken during the respective open seasons in that State, and may be imported from Canada during the open season in the Province where taken, in any manner, but not more than the number thereof that may be taken in two days by one person under these regulations shall be transported by one person in one calendar week out of the State where taken; any such migratory game birds or parts thereof in transit during the open season may continue in transit such additional time immediately succeeding such open season, not to exceed 5 days, necessary to deliver the same to their destination, and may be possessed in any State, Territory, or District during the period constituting the open season where killed, and for an additional period of 10 days next succeeding said open season; and any package in which migratory game birds or parts thereof are transported shall have the name and address of the shipper and of the consignee and an accurate statement of the numbers and kinds of birds contained therein clearly and conspicuously marked on the outside thereof; but no such birds shall be transported from any State, Territory, or District to or through another State, Territory, or District, or to or through a Province of the Dominion of Canada contrary to the laws of the State, Territory, or District, or Province of the Dominion of Canada in which they were taken or from which they are transported; nor shall any such birds be transported into any State, Territory, or District from another State, Territory, or District, or from any State, Territory, or District into any Province of the Dominion of Canada at a time when such State, Territory, or District, or Province of the Dominion of Canada prohibits the possession or transportation thereof.

Bag Limits on Certain Migratory Game Birds.—A person may take in any one day during the prescribed open seasons under the Federal regulations not to exceed the following numbers of migratory game birds, which numbers shall include all birds taken by any other person who for hire accompanies or assists him in taking migratory birds:

Ducks (except wood duck and eider ducks).—Twenty-five in the aggregate of all kinds.

Geese.—Eight in the aggregate of all kinds.

Brant.—Eight.

Rails and gallinules (except sora and coot).—Twenty-five in the aggregate of all kinds, but not more than 15 of any one species.

Sora.—Twenty-five.

Coot.—Twenty-five.

Greater and lesser yellowlegs.—Fifteen in the aggregate of both kinds.

Wilson snipe or jacksnipe.—Twenty.

Woodcock.—Six.

Doves (mourning).—Twenty-five.

Scientific and Propagation Permits.—Permits may be granted by the Secretary of Agriculture for the collection, possession, and sale of migratory birds, their nests and eggs, for scientific purposes, and for the taking, possession, purchase, and sale of migratory waterfowl for propagation and the sale for food purposes of migratory waterfowl reared in captivity. Blanks on which to make application for permits may be obtained from the chief of the Bureau of Biological Survey.

Penalty.—A fine of not more than $500 or imprisonment not more than six months, or both, is prescribed for violation of the act or regulations thereunder.

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DEPARTMENT OF AGRICULTURE

MENT BULLETIN No. 1246

▼ August 13, 1924
Revised March, 1927

CLASSES AND GRADES
DRESSED BEEF

By

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